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THE MAGAZINE OF BROADBAND TECHNOLOGY

CED

Fiberoptics move into the future

Cable outages can be controlled!

LAN buyers: where have they gone?

CATV FREQUENCY CHART

CED

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Washington Bureau 1625 I Street, Suite 615, Washington, D.C. 20006, (202) 835-0900.
New York Bureau 432 Park Avenue South, Suite 1109, New York, N.Y. 10016, (212) 213-3110.

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About the cover
New methods of preventing cable outages—many caused by lightning—are being tried by operators. Photo used courtesy of William P. Winn, Langmuir Laboratories of the New Mexico Institute of Mining and Technology.

INTRODUCIN
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If you install dropwire you're going to scream with delight when you see M/A-COM's new Multidrop bundles. They're perfect for apartments, condos, schools, hospitals, anywhere one dropwire just won't do.

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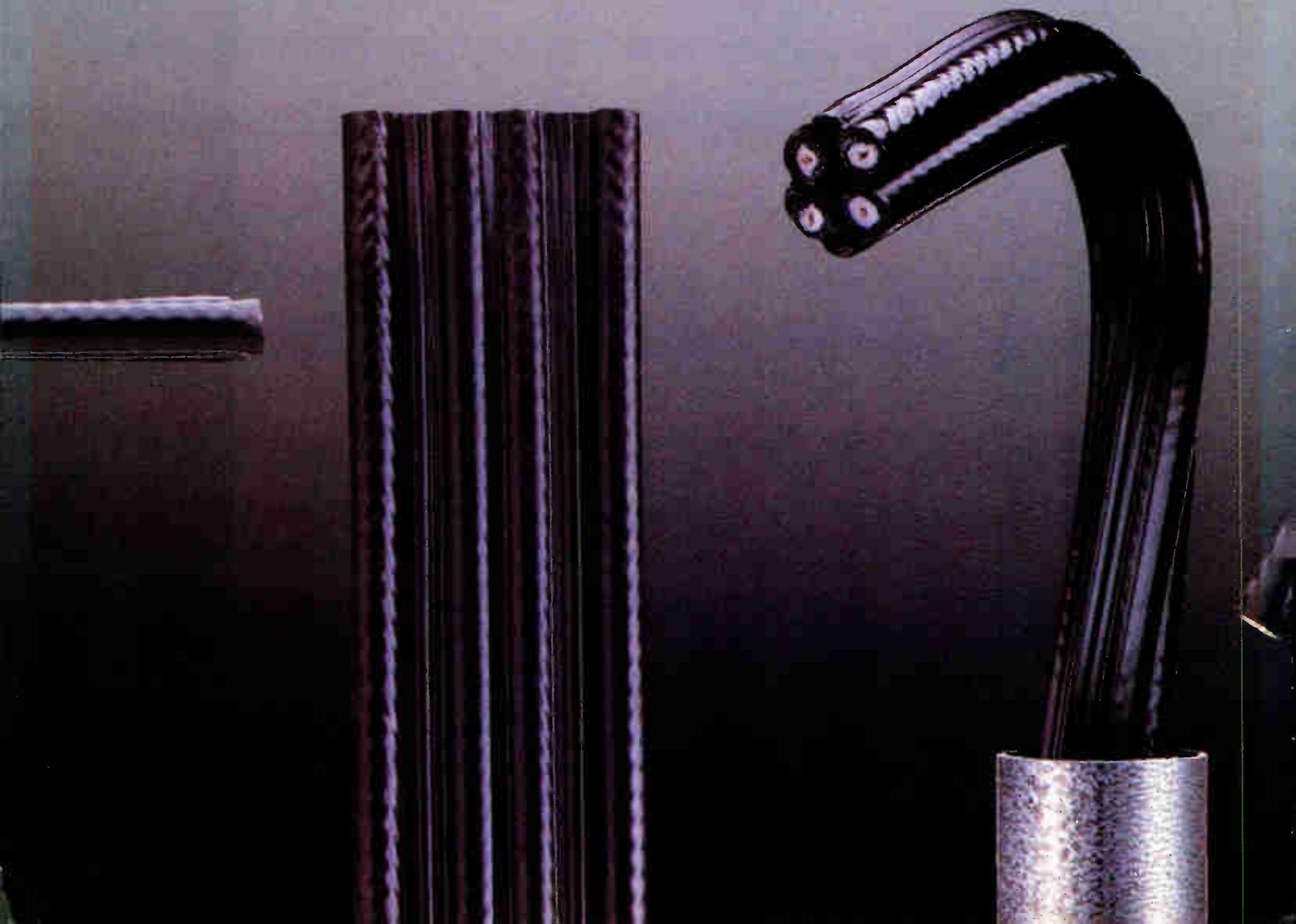

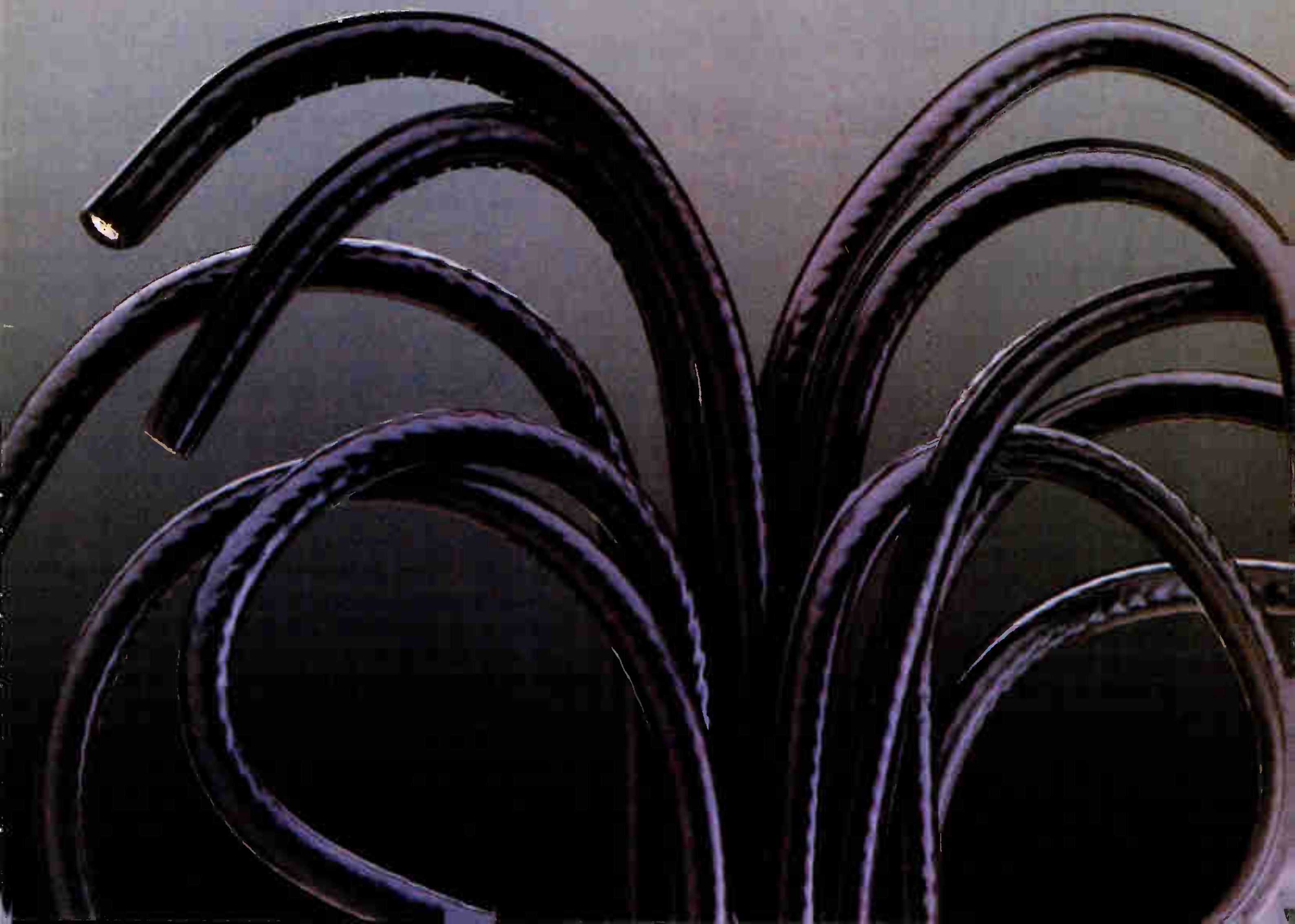

spotlight

Jim Chiddix

New technology essential to Chiddix

Experimenting with new technologies in order to bring his subscribers improved service has always been a high priority to Jim Chiddix, senior vice president of Oceanic Cablevision Inc. in Honolulu, Hawaii. But it's going to be even more important over the next decade, he says, to find ways to deliver service cost effectively to counteract the threat posed by alternative delivery systems.

Because of Hawaii's remote location and difficult terrain, cable systems there have often started at a disadvantage. Consequently, it was there that some of the early tests with satellite signal delivery, stand-alone pay television, pay-per-view and now, fiberoptics, have taken place.

"It was a fairly innovative place, but more out of desperation than out of cleverness," says Chiddix when discussing the Oceanic system of 10 years ago. Because the system had little to offer people who already had good off-air reception, Oceanic had to look for ways to set itself apart. Therefore, it was an early player in pay TV, satellite-delivered programming and addressability.

For Chiddix, a native Pennsylvanian, it was a trip to Hawaii during his senior year at Cornell, where he was studying electrical engineering, that resulted in his permanent relocation to the island state.

"I fell in love with the islands" immediately, says the 40-year-old Chiddix, who found work as a crewman on a charter sailboat. "That was a great way to get to know Hawaii but I rapidly found that I had to get a job that actually paid money." He then stumbled upon Cablevision Inc., a small rural lease-back system owned by the telephone company and located near the boat harbor.

"I began by repairing headend equipment and rental TV sets and nobody else could do that," Chiddix says. So he became the system's technical manager.

After the FCC ordered the telcos to divest themselves of all lease-back systems, Chiddix moved into the management of the system. "I suddenly found myself general manager," he recalls.

After successfully rolling out pay television, Chiddix turned his efforts to designing and manufacturing videotape automation equipment. These devices provided automated playback of pay TV signals and automated tape delay of satellite feeds, which was made necessary by the number of time zones between Hawaii and the mainland. The company that he founded, CRC Electronics, later made commercial insertion equipment, providing cable systems with another source of revenue.

By 1978, Chiddix became engineering vice president for Oceanic Cablevision, a system which at that time had about 30,000 subscribers. After overseeing the installation of one of the first earth stations in Hawaii, Chiddix rolled out pay TV services and invested in addressability through an early Oak system. With the advent of addressability, Oceanic was able to explore pay-per-view and added tiers of pay services.

In 1981, Oceanic was acquired by ATC and a steady growth period ensued. Oceanic, through acquisition and construction, has grown to be the seventh largest system in the country, with about 170,000 subscribers.

But operating the system had its challenges. In order to improve service, Oceanic reconfigured its microwave delivery system, built FM video trunks, experimented with data transmission and now offers nine pay services plus PPV.

In recognition of his efforts to provide Hawaii with the latest technological advantages, the NCTA awarded Chiddix with its Engineering Award for Outstanding Achievement in Operations in 1984.

But he hasn't stopped there. In 1984, Oceanic acquired a system on the windward side of Oahu that provided a huge technical challenge to Chiddix.

Because the headend was located on one side of the mountains and the subscribers were on the other side, the system offered poor quality signals and had severe power problems.

Because no acceptable microwave path was available, Chiddix oversaw the installation of a long-haul passive fiberoptic system that brings high quality signals 14 miles through the mountains.

"It was an absolutely fascinating project," recalls Chiddix. And because he could find little information on the subject, Chiddix has since presented papers to the NCTA concerning the application of fiber to cable systems. And although he is impressed by fiber's capabilities, Chiddix says it should be considered to be just another tool to be used to deliver quality signals.

In spite of cable's rapid growth over the last several years, Chiddix says he sees the next decade as the most challenging times for the industry.

"My biggest concern is our being in a position to compete effectively with what seems to be an inevitable and fairly effective competition from DBS. We are going to be competing with a service that is inherently more reliable and capable of better quality than our long cascades of cable equipment. And when that day comes, it's very important that we have our product mix set, be consumer friendly, responsive to consumer needs and have our costs under control so we can be price competitive," says Chiddix.

In the meantime, cable subscribers in Honolulu can rest assured that they will be on the receiving end of some of the most recent technological advances in the industry. Jim Chiddix will see to that.

—Roger Brown

HOW TO TAKE THE RECALL OUT OF THE INSTALL

Belden's drop cable with DUOBOND PLUS™ shield helps you prevent costly call-backs. It's also the most shield-effective drop cable in the CATV industry.

Easier termination for maximum shielding integrity.

The DUOBOND PLUS shield features a foil/braid/foil construction with a shorting fold in the outermost foil which provides superior shielding effectiveness to typical 4-layer shield constructions. The transfer impedance graph demonstrates this effectiveness.

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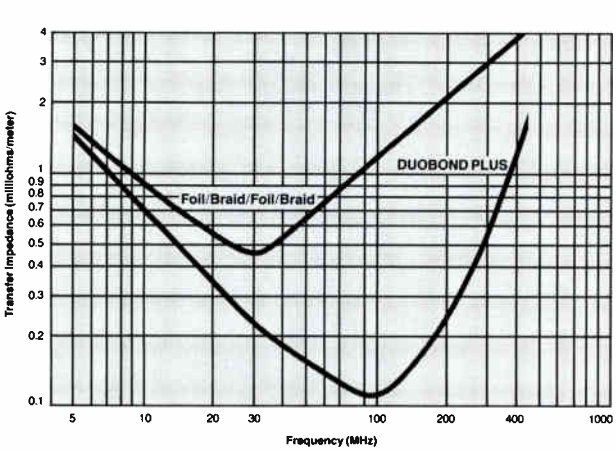

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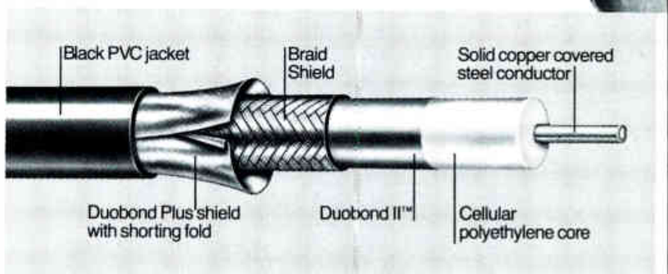

The inner foil of the DUOBOND PLUS shield is bonded *directly* to the core. Foil pushback and signal leakage problems are eliminated. Protection from shielding degradation is eliminated during installation–where most shielding problems occur.

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my turn

Expand your goals beyond the dBs

Forty years ago, I met an interesting young man, age 17, a senior in high school; bright, activist, a sort of angry young man who wanted the world to change its ways, day after tomorrow at the latest.

George Jackson had a couple of problems. He was blind, but not from birth; at an early age, he suffered a serious illness that left his eyes atrophied and useless. Had good medical care been available to him, his eyes could probably have been protected and saved, even in the early '30s.

But he had another problem: he is black, and medical care was not available. So George was blind when I met him.

The difference between courage and foolhardiness is sometimes hard to define. George was brave; brave beyond all reason. One day, on a dare, stone blind, he rode a bicycle for three blocks through the heavy traffic of cars, trolleys, buses and trucks on Bloomfield Avenue in urban New Jersey. He made it, but admits he was scared stiff.

George never uses a white cane, and accepts the arm of a guide most reluctantly. Next door to our home, close to the sidewalk, was the stump of an old birch tree, about three feet high. I warned George about the possibility of miscounting the trees and making a wrong turn. To say that he was insulted would be a gross understatement. He never touches the trees; he just counts them as he goes past, and he would certainly not be fooled by a stump.

As an angry young man, with the courage and determination to do what he saw needed to be done, George contemplated violence to protest the rampant discrimination he saw all around him. (Blind though he is, he sees plenty). Cooler heads prevailed, and the violence did not happen.

After graduating from high school, George entered Seton Hall, a catholic college in Newark. He tells me he was kicked out, probably for his unceasing activism and protest.

Then I lost track of him.

Last January, nearly 40 years later, I saw him on national TV. Dr. George Jackson, PhD, professor of social services at Howard University in Washington, was being interviewed by Bill Moyer during that disturbing CBS documentary on teen pregnancy.

George is now a mature, 57-year old professor. His violent dreams are long past; but his active determination to stand up and be counted persists. He was one of two candidates for provost at Antioch College, but lost out when he answered the president's question by saying he would actively support student efforts to pursuade the college to disinvest in South Africa.

Engineers and technicians should have goals and interests beyond the dB's, whether that means decibels or dollar bills. We need to be inspired once in a while by the courage and determination of the George Jacksons of this world, BA, MA, PhD.

Who knows? Perhaps our own handicaps may be our golden opportunities.

Archer S. Taylor, Senior Vice President, Engineering, Malarkey-Taylor Associates Inc.

in perspective

IS-15 is rolling

Although not everybody in CATV will welcome the decision, the NCTA Engineering Committee has voted to endorse the EIA's proposed baseband interface standard IS-15. The EIA itself already supports the interim standard, which might be adopted on more than an interim basis in a year or so. An NCTA subcommittee has been set up to work for widespread industry adoption of the standard, which could, in 10 years or so, dramatically lower the cost of addressability and open the door for subscriber ownership of home CATV terminals. In essence, IS-15 proposes a universal TV interface that would, among other things, reduce the cost of scrambling, since it takes the tuner, IF sound demodulator and modulator out of set-top converters.

The plug would return all tuning functions to the cable-compatible TV, lower operator capital investment in the home, and open the door to much more rugged signal security at a much lower cost. The interface would operate at baseband, not IF. And there's the rub, for some people. Although work on the baseband interface has been proceeding for quite some time, there's been some opinion that the interface really ought to operate at IF, taking advantage of the industry's current preference for RF, rather than baseband, scrambling techniques.

Debate has been vigorous on this issue, for all kinds of reasons. As is always the case, standards aren't vendor neutral. Any given standard can help or harm the business interests of particular parties. The debate over IS-15 was no exception. Some decoder manufacturers favored the IF version of the interface; others the baseband. Still others wanted both. The arguments in favor of RF went something like this: 75 percent of existing CATV systems that are scrambling are doing so at RF, not baseband. Current sales, as well as the installed base, reflect that ratio. An IF interface would be backwards compatible; not so with the baseband version. Also, from a converter manufacturer's perspective, IF is easier to adopt.

On the other hand, there were arguments against doing the interface at IF. Some of the TV set manufacturers didn't like it, because there's no easy way for them to break in to the main circuit board for an IF loop-through. Major design work would be necessary, and this would delay implementation of the standard by an estimated two or more years, even after the standard is adopted. Likewise, set manufacturers don't want two interfaces on the back of the TV set. Neither do lots of CATV industry leaders. "What's the point of having a standard at all if you're going to have two?," they argued.

Time also was a factor. Getting widespread consumer and TV manufacturer acceptance of the plug will be a long-term proposition. The added delay just didn't make sense to many industry thinkers. "We've just got to move," was the feeling. Especially since it's clear the set manufacturers won't move until CATV does first.

There are now several big questions. Will enough MSOs demand the IS-15 standard so that it does in fact become a real standard? How soon will quantities of TV sets be outfitted with the plug? How much will it cost converter manufacturers to adapt RF converter technology to the plug? For the most part, vendors have indicated they can do so. Scientific-Atlanta, for example, supports IS-15 as is. S-A agreed that an IF interface would lower the cost of decoders in the short term, but worried about the longevity sync suppression scrambling at RF. S-A probably will continue with RF scrambling, but allow optional decoding at baseband, to maintain backwards compatibility with their installed base of systems.

Oak is fully behind IS-15, as the Sigma system is fully compatible. The older RF technology can be accomodated at baseband, but the future of the company clearly is with baseband technology.

General Instruments really would have preferred an IF interface, although it supported the baseband standard as well. Obviously the Tocom line is at baseband, so GI is familiar with the technology. But most of the company's product operates at RF.

Zenith had roughly the same position, arguing for both a baseband and an IF interface. The Z-Tac line should have no trouble with the baseband plug. The real trouble though is the company's new phase modulation system for RF scrambling. It almost certainly won't work with the baseband standard.

It would appear that prospects for an IF version of the interface now are nil. The NCTA Engineering Committee several months ago voted to ask the EIA for an IF version of the interface, but has now rescinded that request. Almost certainly, the committee would oppose the addition of an IF interface.

The next item on the agenda, aside from getting industry adoption of the new standard, will be some universality of control over the scrambling process, says Wendell Bailey, NCTA vice president, science and technology. "What we need is a group of two or three modes and techniques for scrambling. It's possible that one of the methods will be fairly traditional; some version of sync suppression—it can be done securely."

Most likely, the standard will get a big push from ATC and Viacom. Both have leading engineering talent in favor of the standard, and active on the committee seeking adoption of IS-15. Maclean Hunter seems to be leaning towards it as well. One thing is certain. TCI has to endorse the standard.

Desired specifications of pay cable traps

A list of desired specifications is developed in this paper, with a discussion of each, for a trap in channel A (121.25 MHz). The specifications are intended to describe a filter whose performance will be predictable over a wide range of environments and with many different TV receivers. Also discussed are the differences to be expected in operating parameters of filters for channels higher and lower than channel A.

Considerations discussed herein are: the critical portions of the signal to be trapped, the parameters needed to effect scrambling action in the receiver, specifications geared to ensure time stability, and specifications intended to cause poor to indiscernible audio in most receivers.

Notch Frequency: Desired visual carrier ±2 kHz
Temperature: -40°F to 140°F
Depth of Notch: 45 dB at room temperature
Insertion Loss: Adjacent visual carrier 2 dB; all others 0.75 dB
Return Loss: All channels outside 3 dB points 16 dB
Frequency Stability: ±75 kHz
3 dB Bandwidth: 10 MHz
3 dB Notch Width: 32 kHz minimum; 100 kHz maximum
Power Protection: Withstand 250 VAC from center conductor to sheath
Shock: Withstand 20-foot fall to concrete
Mechanical Configuration: Not removable with common hand tools
Warranty: One year

The rapid growth of pay cable has resulted in a heavy demand for a device previously unknown to the cable industry: an inexpensive (relative to other filters in use in the industry), highly stable, weatherproof filter (or trap) designed to render a pay signal unwatchable, available in large quantities to accommodate any given channel line-up found in the industry. Such a device is difficult to specify, and consequently not all filters are purchased under the same specifications.

Dan Pike, Vice President, Engineering, Prime Cable
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> The cable industry is calling for an inexpensive, stable trap.

It is to the benefit of the operators and manufacturers if both describe the unit by the same manner of specification, with changes in absolute values to accommodate special circumstances found in different CATV systems. The desired specifications are listed here with the appropriate discussion of each one.

Notch Frequency—The notch frequency should be specified as the assigned visual carrier frequency of the pay channel with a tolerance of ±2 kHz to allow for slight variances between equipment. This specification is intended to ensure that the center and deepest portion of the notch lies in the area of its maximum effect. Other parameters will deal with the shape of the notch.

Temperature—The temperature range commonly specified for most CATV equipment lies from -40°F to 140°F, and these units should be compatible with other equipment operating in the industry. Certainly southern coastal areas might wish to relax these somewhat for their particular needs, but filters with good stability and temperature compensation generally have little difficulty meeting the -40°F to 140°F temperature range.

Depth of Notch—The depth of the notch can be specified to satisfy one of two desires: either to effect scrambling action in the receiver or to reduce the visual carrier and consequently the carrier to noise value of the signal displayed on the receiver to that which is generally accepted to be unwatchable. Most late-model color receivers will not reliably synchronize when the video carrier approaches an absolute level of -35 dBmV.

The maximum drop levels found in most systems rarely exceed 10 dBmV such that a notch depth of 45 dB is adequate to effect scrambling action in most receivers. If the notch, however, does not retain that value through the channel of interest but rather only very near the visual carrier, as is the case in a pay cable trap, there are appreciable energy components within the desired channel (particularly within the areas of the color subcarrier and sound carrier).

In addition, most receivers develop AGC voltage by reference to the horizontal sync information, which is located within 15,570 Hz of the visual carrier. With the gain of the receiver circuitry at a relatively high value, these added energy components may aid scrambling effect by the generation of intermodulation products in the receiver IF circuitry and detectors. Also aiding this effect are any adjacent channels that lie in the bandpass of the tuner and IF response of the receiver.

Added effects

These added effects may be used as a basis to modify the 45 dB specifications at room temperature to include a

Cable Classics

Traps, for the control of premium channels, have been in use in cable for more than 10 years. In that time many trap products (and trap manufacturers) have appeared on the scene. The more successful may well have benefitted from this NCTA paper outlining technical requirements for effective pay TV traps.

Do you know what notch depth, in db, is required for effective scrambling action? Or what notch width is required to effectively remove synchronization components of the television signal? You may be aware of the potential to degrade the performance of an adjacent channel, but do you know what the effects may be or how to minimize them? The author says now that the concept introduced in this paper, a 20 foot drop test (on to concrete—no less!), has proved to be a particularly effective means of qualifying designs to assure long term stability.

This paper by Dan Pike provides not only a list of the essential specifications, but also a rationale for each.

Graham S. Stubbs, Vice President, Science & Technology, Oak Communications

A poor picture is defined as one whose carrier to noise ratio is 30 dB or less.

tolerance for the temperature extremes of 5 dB to allow a 40 dB specification at the two temperature extremes of -40 and +140 provided that the filter returns to 45 dB at room temperature. The depth of notch specification, then, should read 45 dB at room temperature and 40 dB at the temperature extremes.

If the goal is to simply provide a snowy picture that may be considered unwatchable, then the value of the notch does not necessarily have to be so high since a 40 dB trap in conjunction with a converter with a 13 dB noise figure and 10 dBmV input leaves a carrier to noise ratio contribution of the TV tuner and the system itself as being negligible.

A poor picture has been defined as one whose carrier to noise ratio is 30 dB or less. A barely viewable picture has been defined as one having a 27 dB carrier to noise ratio such that any value below 24 dB could be considered unwatchable. For the protection of the premium channel, however, specifications written for a scambling effect would be advisable.

While a 45 dB notch may render a video signal viewed on a television set unwatchable, it most likely will not have a discernible effect on the audio portion of that signal since a filter designed not to suppress the visual carrier on the adjacent channel by more than 2 dB will not suppress the aural carrier by more than approximately 10 dB. In cable systems where the aural carrier is operated 15 dB to 17 dB below the visual carrier, the audio will still be quite discernible.

Virtually every television set used in the U.S. today makes use of the 4.5 MHz difference between the aural and visual carriers with the use of an intercarrier sound technique whereby after IF detection there follows a 4.5 MHz sound detector to recover the aural information.

The level of the 4.5 MHz carrier is directly dependent upon a level of the visual carrier, so it is possible to place a value on the visual carrier at which or below which the value of the 4.5 carrier produces a garbled audio component. This absolute value has been established to be on the order of -45 dBmV to -50 dBmV, which means that a 55 dB or 60 dB trap is necessary if the

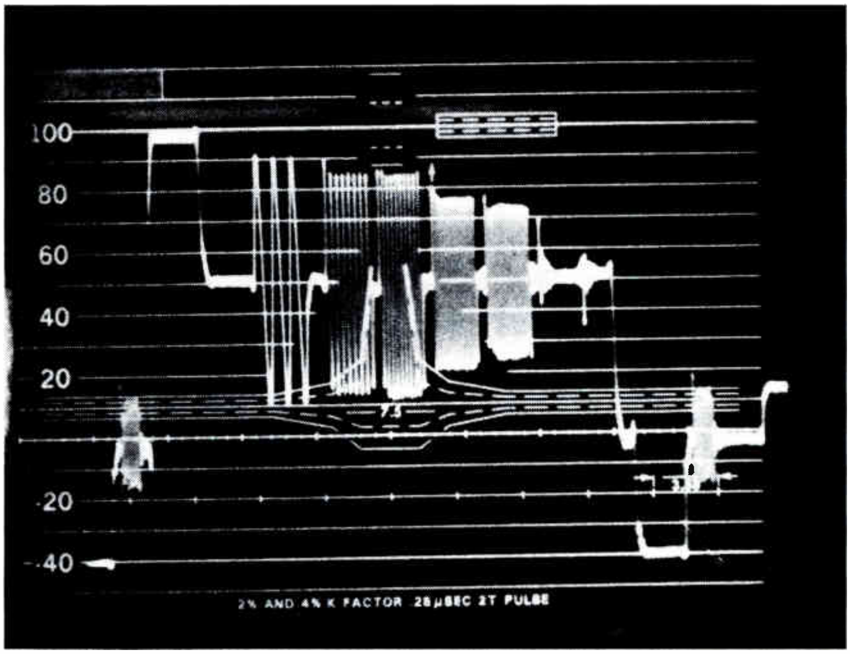


FIGURE 1

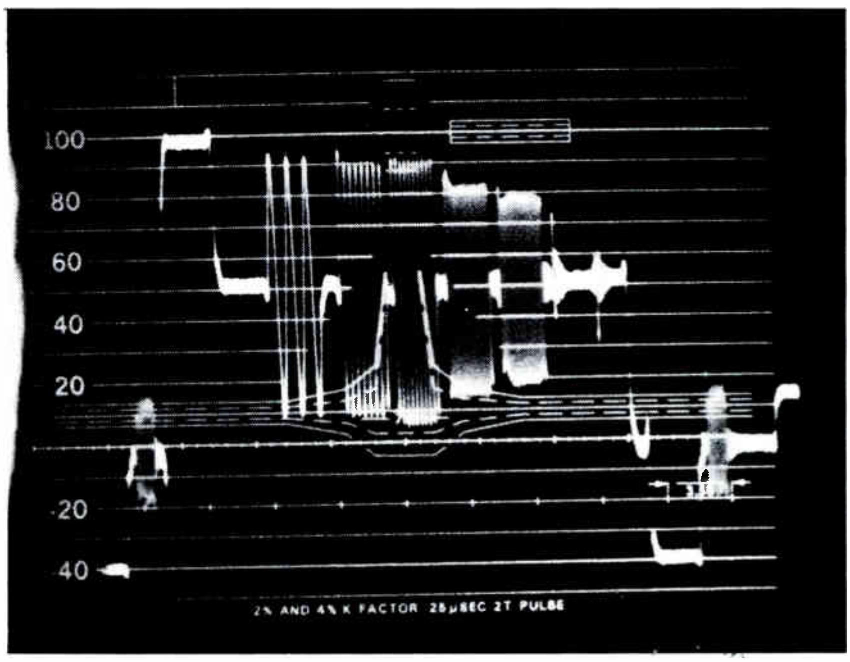
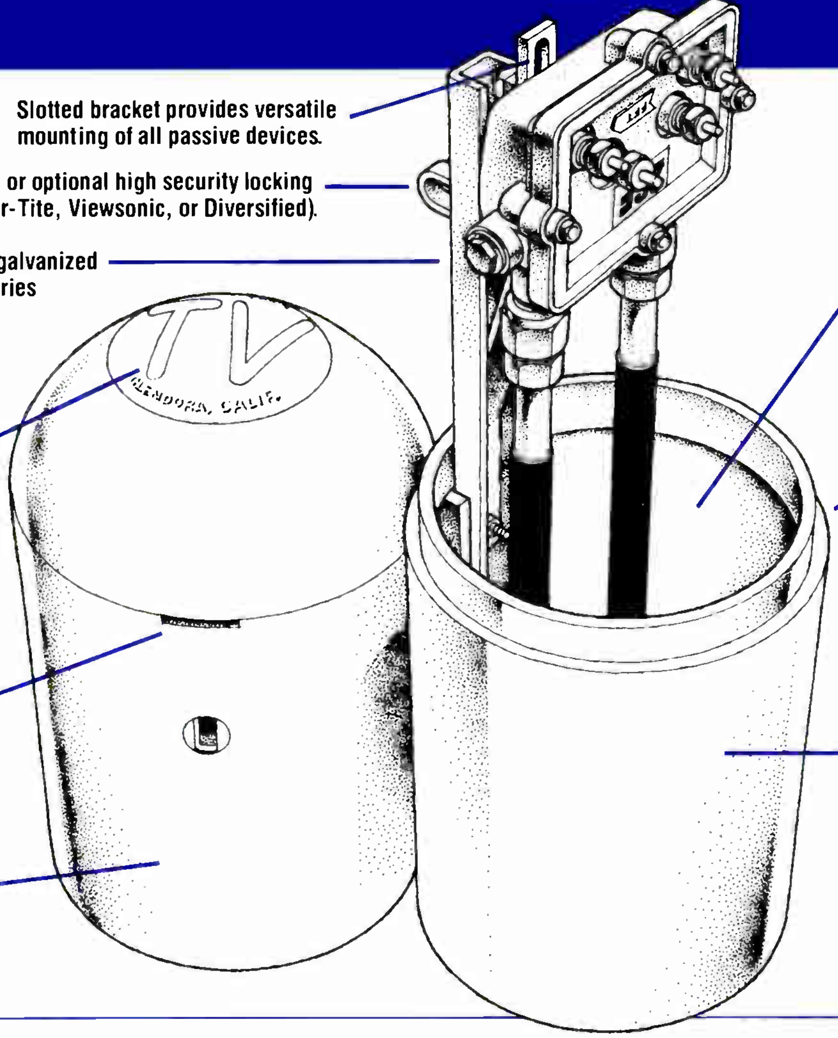


FIGURE 2

Take a good look at Channell's above grade enclosures!



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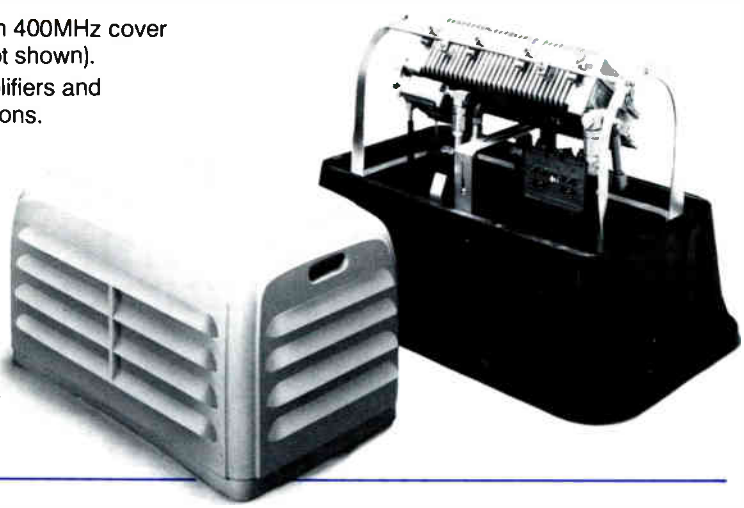

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The reduction of the visual carrier is not absolutely certain to produce garbled audio.

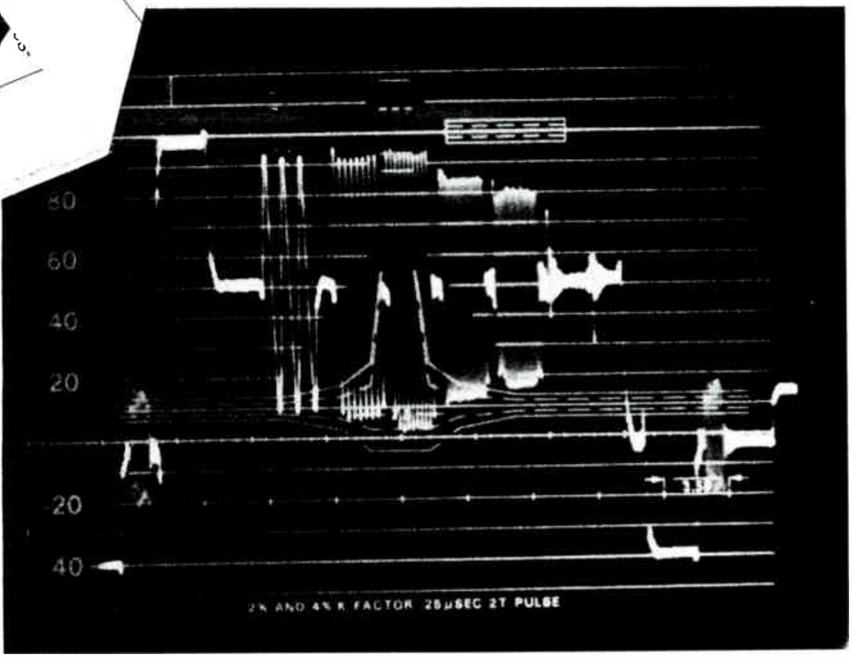


FIGURE 3

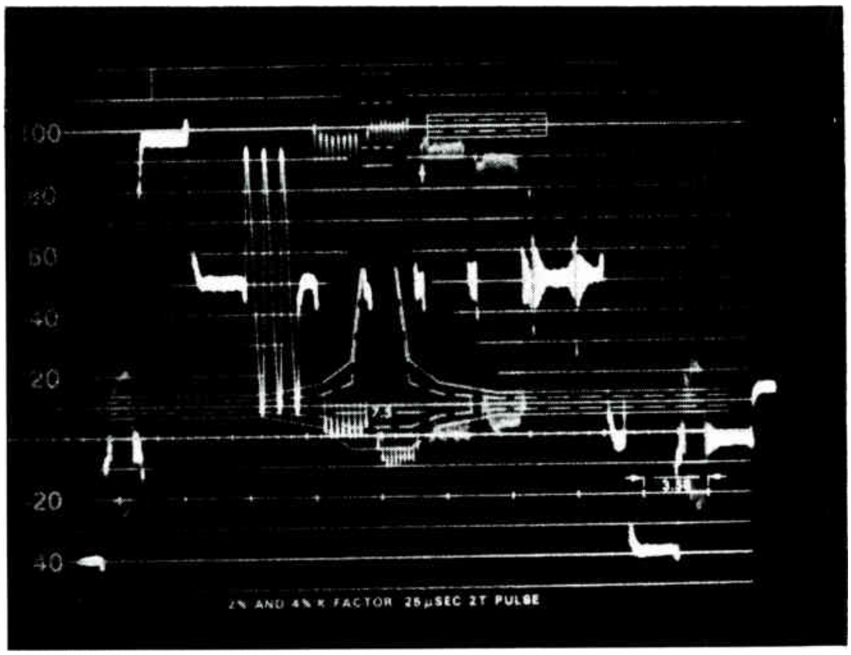


FIGURE 4

maximum subscriber levels are 10 dBmV.

The reduction of the visual carrier is, however, not absolutely certain to produce garbled audio since the pay aural carrier can beat with any adjacent carrier or even with high level luminance components if the trap is very sharp in the IF detection process and produces a 4.5 MHz component that the FM detector in the receiver will receive.

Since the gain of the receiver circuitry is relatively high, many more distortion products will be presented to the FM detector and, depending on the alignment and fine tuning range of the receiver, it may be possible to fine tune to receive discernible pay channel audio even when the pay visual carrier has been attenuated 90 dB or more.

The only sure way to reduce the audio to an indiscernible level in every receiver is to reduce the aural carrier level before IF detection. This may present a problem to upper adjacent visual carriers, particularly for operation above the low VHF channels.

It is very important that the depth of the notch specification be considered in conjunction with the other frequency and bandwidth specifications since it is entirely possible that a 60 dB notch can be placed in a channel in such a frequency position as to be barely noticeable. A 45 dB trap is not effective unless it attenuates the information within ± 15.75 kHz of the pay visual carrier by 45 dB.

Insertion loss

Insertion Loss—Insertion loss for all channels other than the adjacent channel to the trapped channel should be 0.75 dB maximum. This should include any peak to valley or other variations in the response. The adjacent channel carrier should not be attenuated by any value more than 3 dB for the average home receiver to be unaffected, and the figure of 2 dB provides adequate margin for variance between receivers.

While the trapped pay TV channel is not offered to the subscriber and by yet-unqualified opinions doesn't have to be tested to meet the FCC standards, the adjacent channel does have to meet them, and a value of 2 dB at the visual carrier is intended to pro-

Tests have shown that the trained eye can begin to determine differences in the transient response.

vide a reasonable variance in that channel.

Since the filter response will return to about its insertion loss value above the visual carrier and will also drop another dB approximately to the lower channel limit, the recommended FCC limits of ± 2 dB may be met if the 2 dB insertion loss specification is observed for the adjacent channel.

Also, tests have shown (see Figure 1A) that the trained eye can begin to determine differences in the transient response (where the picture contains sharp transitions) but cannot determine variances in the color saturations or hues at this level of adjacent channel attenuation.

Photographs 1-4 show the variance in test wave-forms through a demodulator that may be considered equal in quality to those of the average home receivers. Since the AGC voltage is developed from the 15.750 Hz components lying within 15.750 kHz of the visual carrier, the difference in the amplitude of the upper and lower 15.75 kHz sidebands is very slight and can be neglected.

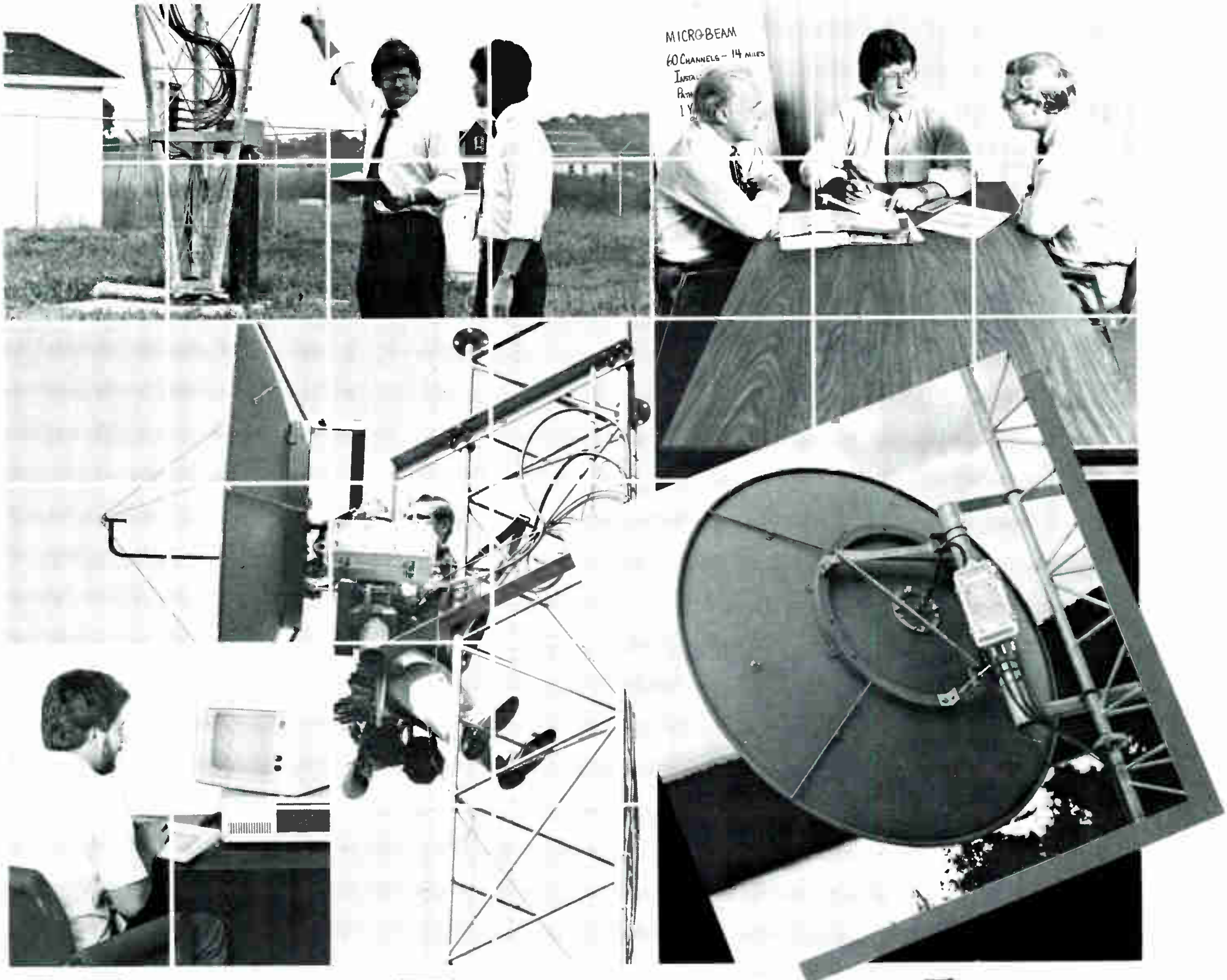
However, there is a discernible difference in attenuation between the components of appreciable energy content at the lower end of the lower vestigial sideband and those of the same corresponding frequencies away from the carrier in the upper sideband, resulting in a reconstituted signal having variances in this response relative to equal amplitudes of components not passing through a trap having non-linear attenuation throughout the adjacent channel.

Since the gain is corrected using reconstituted lower frequency components, which are attenuated by the value of the slope of the incoming RF response, the corresponding value of the slope of the higher frequency components will be greater.

Photos 1-4 show the effects of a reconstituted signal for values of carrier attenuation given in Table 1. Also shown in Table 1 are the values tenuation at the lower limits of the tigial sideband.

Figure 1A shows responses throug the same demodulator with 2T, 12.5T and window test signals. Since most of the energy of the 2T pulse lies in the low-frequency areas of the video signal, its amplitude is affected less than that of the 12.5T pulse. The 12.5T pulse indicates a relative chroma level increase with relative chroma delay.

The 2T pulse reveals that the transient response as well as the amplitude is affected, as may be predicted by the change in phase relationships for those frequencies reconstituted from components above and below the visual carrier since the components on the lower edge of the vestigial sideband are on the lagging edge of the filter and are affected more by any phase difference. The low to high frequency phase variance is apparent by the observation of the 12.5T pulse.



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Reader Service Number 12

Phase relationships will be determined largely by the alignment of the subscriber's receiver.

Phase relationships

These phase relationships, amplitude, variances and transient response differences, will be determined largely by the alignment of the subscriber's receiver, but the effects of the trap will be additive in any case. The fact that the trained eye may begin to see the effects on using an average representative receiver with a filter whose upper adjacent is attenuated beyond the values given in Table 1 is used as a basis for the specification.

Return Loss—Since taps commonly used in CATV systems have return loss specifications of 15 dB or better, the trap used in conjunction with these should have at least an equal return loss except, of course, within the effects of the notch. All channels other than those within the 3 dB points of the trap should exhibit a return loss of 16 dB or better. Of course, systems with taps that have better or worse return losses may wish to alter these numbers slightly.

Tests at United Cable have shown that a feeder line with traps on roughly 50 percent of the tap spigots exhibiting return loss of 11 dB does not result in a measurable difference in the response of that feeder line, nor does it result in discernible impairment of the adjacent color picture or any other channel when viewed by trained observers. The tap values on the tested feeder line ran from the high 20s to 8 dB, and the minimum isolation specification of the taps was 26 dB.

Frequency Stability—The frequency stability of the notch is important to ensure that the critical components remain at the attenuation value that has been chosen. To ensure that a notch retains its position in the frequency spectrum a specification of ±75 kHz across the temperature extremes has been shown to be a valid specification. Measurement of frequency for any attenuation value chosen should not vary more than ±75 kHz over the -40°F to 140°F extremes.

Table 1

Photo	Attenuation, dB at Visual Carrier	1 MHz Below Visual Reference
1	Reference	Reference
2	1.4	2.1
3	2.3	3.0
4	2.6	4.5

Cable TV equipment operates in environments and over bandwidths surpassed only by a few industries.

it a band stop filter, a trap, or a band reject filter, is such that its operating conditions are somewhat opposite to that of most other equipment found in the industry.

It has to operate with very high circuit Qs and very high stability yet over very narrow bandwidth, where the other equipment in the industry operates over a very broad bandwidth. Slight physicial displacement introduced by shock may have catastrophic effects on the action of the filter.

For this reason, the unit must be able to withstand a 20-foot fall to concrete to ensure that it will retain its electrical performance during and after installation. It also gives a relatively good idea that the unit will perform well with long-term environment impacts and gives a good idea that the mechanical exercise caused by temperature extremes over the years will not adversely affect the unit.

If a unit can be installed with common hand tools, it may quite naturally be removed with common hand tools. Since the pay channel represents an annual worth of approximately $100 to the trapped subscriber, the propensity for him to steal the service is dramatically increased over that of the theft of the normal cable service.

Where economically feasible, the filter should lock to the tap mechanically and not be removable except with special tools not normally available. Other alternatives to that, of course, include the use of a locking "F" connector or other arrangement on the subscriber's drop to mechanically lock the drop to the filter rather than the filter to the tap.

The disadvantage of this method is the availability of type F connectors at hobby shops and the likelihood a potential pay subscriber may connect himself at a point on the tap side of the filter. In apartment boxes and some underground installations there is the reliable padlock for security.

Regardless of the type of mechanical security, he may connect himself to a neighboring pay drop. The inclusion of the mechanical locking specification is to indicate to the manufacturer the desireability of that feature.

One year warranty

Cable television equipment operates in environments and over bandwidths surpassed only by a few industries. The inherent nature of this narrow band device suddenly developed for pay cable use dictates the concern for its long-term stability. Component changes, mechanical exercise through temperature extremes, water absorption, potting compound aging effects and countless other factors can affect the long-term stability of the unit. The unit should be warranted to exhibit these outlined specifications for a period of one year.

These specifications were drawn for units operating on Channel A and represent reasonable specifications for that spectral area. Filters that are intended to operate at higher frequencies into the high VHF or super band must have relaxations in the 3 dB bandwidth since that parameter may be expressed as a percentage of center frequency and used as a rough estimate of. performance for channels above the lower mid-band.

For channels in the low VHF area the 3 dB value may be expected to reduce by approximately the same percentage value.

There are many other conditions that come into play in the actual design, and the use of the percentage estimations yields only crude approximations. Certainly with the vacating of upper adjacent and lower adjacent channels units may be used on channels in the high VHF and super band.

However, the sacrifice of those two channels involves the sacrifice of an important resource of the system—that of valuable spectrum space that can never be used for distribution of information to all subscribers except when the filters are removed.

Units operating in the low VHF band have a spectral opening given them by the FCC in the 4 MHz space between channels 4 and 5. Units on

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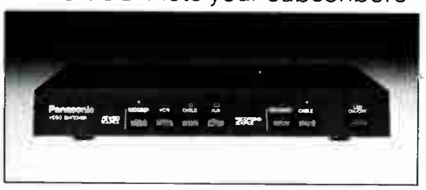

record a pay channel while they watch a basic channel. In fact, your subscribers can record any CATV channel while they watch any one of four video sources. Like a second VCR, a second converter/descrambler—even a video camera.

To get the VCS-1 message to your subscribers, Panasonic provides extensive marketing support. Like cooperative advertising funds, statement stuffers, point-of-purchase displays, create kits containing complete print ads—even a TV spot to run on your local avails.

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Our Non-Addressable Remote Converter, the TZ-PC120, features

68-channel capability. Each channel is precisely controlled by phase-locked synthesized tuning, switchable between HRC and Standard/IRC offsets.

We didn't forget the favorite-channel memory. In fact, the TZ-PC120 can store up to 68 channels. It also features direct-access tuning, two-speed all-channel scan and last-channel recall. All this without an "Enter" button.

When it comes to our optional

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parental control, the TZ-PC120 lets your subscribers lock out the sensitive channels they don't want their children to see, without affecting the remaining channels. And thanks to our innovative *Stored Charge Non-Volatile Memory,* parental control channels and other memory functions will not be affected by a power outage. There's also an 18-button infrared remote control. It's compact, controls every function and comes complete with Panasonic batteries.

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The new addressable PC-200 converter.

When it comes to your headend, the new PC-200 addressable converter

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*Based on in-warranty repairs as of 4/1/86 from all converters sold since 8/84

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Reader Service Number 19

Observation of filter performance may be done by watching the trapped channel on service calls to non-paying subscribers.

channel 5 have that 4 MHz with which to recover their 3 dB bandwidth without adversely affecting the aural carrier of channel 4.

Also, some designs incorporate 3 dB bandwidth sufficiently narrow to be used in the lower four channels without adversely affecting lower adjacent sound or color subcarriers, while keeping the required stability. The spectral area below channel 2, of course, contains no useful information to the subscriber, and units operating in that area have no lower adjacent problems.

The program of trapping non-pay subscribers must be carried through with the highest integrity possible for many reasons. The filter protects a service with an annual worth of $100 or more, and its performance has an effect on the number of pay subscribers since inadequate performance may let a poor signal reach the home.

A poor signal relative to the other cable signals offered at a cost of a few cents per signal per month, may, in the eyes of a subscriber, become a signal good enough not to be worth $8 to $10 more per month to be made better.

Also, subscribers paying for the premium channel often fail to see the dollar difference between their good signal and their neighbor's free snowy signal. These undesirable events may be avoided by 100 percent incoming inspection and rigid testing for these specifications presented on a sample lot of units from each production run.

Continued observation of filter performance may be carried out by observing the trapped channel on every service call to a non-pay subscriber.

General trends that may be noticed during the testing of filters may be the slight dependency for the scramble effect on the average picture level, depths of modulation and picture information.

A test pattern such as the cross hatch and dot pattern where rapid transitions are apparent will effect the scrambling action more so than dark movie scenes since dark scenes have more visual carrier available to the receiver, and any scrambling action introduced by the rapid transitions is not apparent.

For systems using converters, a receiver that does not synchronize with the fine tuning at its normal range may synchronize if the fine tuning is adjusted to one extreme partly because of the frequency response of the television receiver and partly because of the response of the converter.

Perhaps by the establishment of a set of desired specifications with the flexibility to adapt them to every particular situation to be encountered in the CATV industry, the industry's needs may be more closely conveyed to the manufacturer, and the manufacturer's response may be more closely correlated with the predetermined CATV operator's need. ■

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Correction

In *CED*'s July issue, an error was made in the SMATV Buyers Guide. On Budco Inc.'s listing, the National WATS number should read (800) 331-2246 and the in-state (Oklahoma) collect number is (918) 252-3420.

CED apologizes for any inconvenience or problems this error may have caused.

Outage control problems: here's what to do

Lightning and trench digging are the major causes of cable outages.

The onset of lightning during a passing thunderstorm can be a hair-raising experience for anyone, but for a cable system operator, it can be a real headache. With lightning often attracted to aerial cable by the power line that usually runs just above it, systems in certain areas of the country may suffer the effects of hundreds of strikes every year. And while the vast majority of those strikes are not direct hits on cable plants, the surges that transfer to the cable have enough power to easily blow amplifiers, causing an unwanted outage.

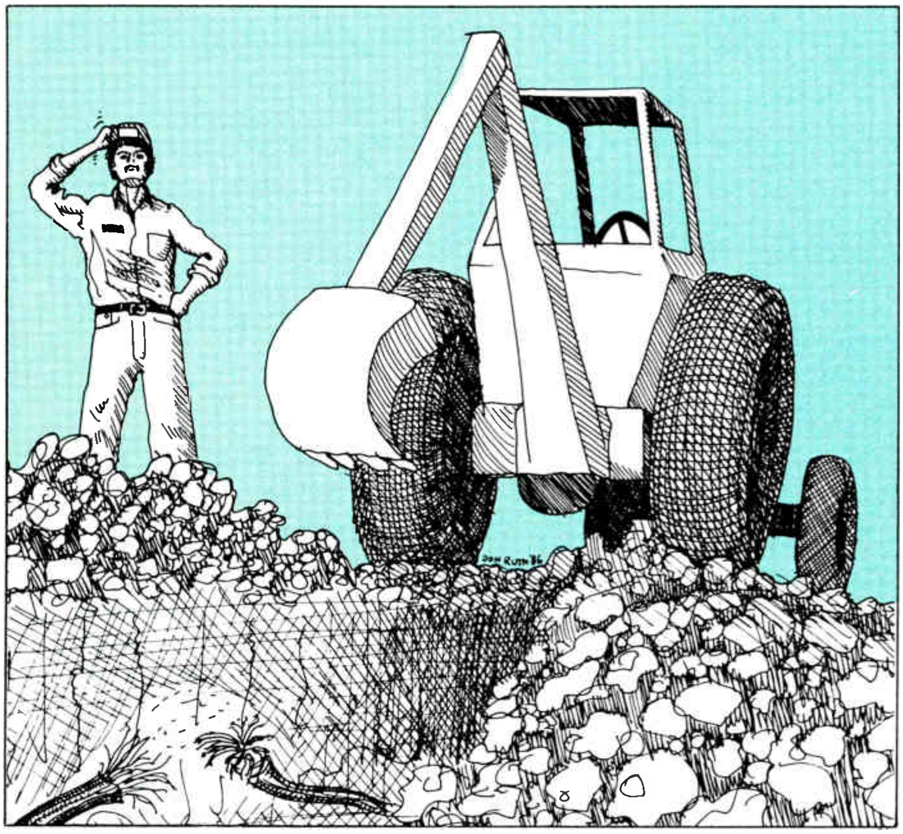
In order to reduce the effects of lightning, it's important to bond and ground each pole beyond the specifications called for by national electrical codes, says Roy Ehman, vice president of engineering for Storer's Kentucky and Virginia region.

"When I say effective grounding, I mean driving successive eight-foot lengths of rod into the ground until you can drive them no further." He suggests that these "private" grounding rods—used to drain surge current—be driven as deep as 24 or 32 feet deep. "If you're lucky, you might hit water or subterrainian moisture and achieve a ground of less than one Ohm," he says.

Beyond that, surge arresters that last for several milliseconds and have a fast rise time should be placed throughout the system, Ehman says. "I don't believe surges travel through the power supply," he says. "I believe they come directly induced into your neutral, hence into your strand and your cable itself. That's where the protection needs to be."

Nick Worth, vice president of engineering at Telecable, says it's important to realize surges come through the power company's connections. So, in his systems, he has installed protectors capable of absorbing up to 500 joules of energy at the input to standby power supplies and at the headends.

In areas where there is a lot of electrical activity, Telecable has gone the extra mile to effectively bond it's strands.


Trench digging often results in cable outages.

Bonding tricks

"The National Electrical Safety Code requires us to bond our strands to the telephone company's strands and to the power company's vertical grounds," Worth says. "It's a safety requirement we must do but it creates a problem in that it gives a pass through which lightning can be transferred from the power lines to our plant.

"A little trick we've discovered is to run our own vertical and bond at the base of the pole. And we also take some jacketed bonding wire and wrap it around a suspension clamp bolt to make an RF choke and we use that as a bond. It seems to help keep from coupling some high frequency surges into our plant," he says.

Bob Dattner, vice president of technical operations for Media General in Fairfax, Va., grounded the input and output of each amplifier in his system, but isn't convinced it's been effective for him. "We did it because it seemed like the right thing to do and we spent a lot of time checking those grounds," he says. "Whether that saves me outages or not, though, I don't know."

In spite of all the precautions, lightning can still cause outages, so it's important to beef up standby power supplies where lightning strikes most often, says Telecable's Worth, who has some systems backed up 100 percent while others are covered on strategic major trunk runs. But, after the decision is made to add standby power, it is critical that the supplies be maintained properly so that they will work when needed.

After selecting a good, reliable unit, Worth says, the key to keeping it in good shape is to properly set the battery charge voltage with a digital voltmeter. "Even a few tenths of a volt error can cause batteries to boil over and

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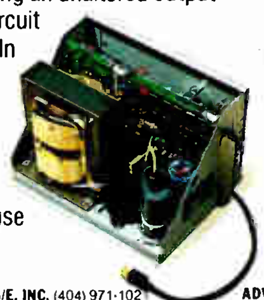

This concept needs fewer components which translates into **higher reliability**. Because the inverter cannot be activated, even with the line relay contact "stuck", this concept also gave us the fail-safe feature that helped us to obtain both **UL** and **CSA** approvals. And that gives a good product a good name.

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Reader Service Number 22

The battle of fighting construction dig-up-related outages has become one of economics.

drastically shorten their life," he advises.

It is that need for constant maintenance that has kept Dan Liberatore, director of engineering at Adelphia Communications, from investing in standby supplies. "Standby power supplies are good, if you keep after them," he says. "But if you put them up there and never pay any attention to them, they're a waste of money."

That money is better spent working with the power company to solve outage problems, says Fritz Baker, regional engineer for Viacom in Cleveland. "Typically, a cable system will pay $2,000 to $3,000 for a good standby power supply," he says. "I would rather approach the power company and pay that amount of money to clean up the power grid that serves the cable plant. I would rather fix the problem than apply a band-aid solution."

Media General's Dattner says, however, that his biggest cause of outages is construction dig-ups. It's an ongoing battle for Dattner, who has 1,000 miles of underground plant in an area where they're building thousands of new homes every year. And the battle has turned to one of economics.

"I think the best thing to do is to hit these guys in the pocketbook—let them know you're serious. They're still going to cut you, but you need to get after them for some money and maybe some will be more cautious." And because a cut cable will eventually have to be completely replaced, Dattner bills the guilty party for the total replacement cost.

In cities where there is less construction activity going on, most systems can benefit from joining a "blue stake" committee that advises systems of any digging that will be taking place so system lines can be identified. "That seems to be working fairly well" for most of the Jones Intercable systems, says Alan Kernes, vice president of engineering.

Some Telecable systems have been using an orange tape buried a few inches below the surface above the route taken by cable, says Worth. This way, when a person digs up the tape, he'll be alerted to what's underneath. Additionally, Worth says Telecable tries to bury its cable at a depth of two feet, a concept Viacom's Fritz Baker agrees with.

"The key (to avoiding dig-ups) is to be the deepest guy in the block," says Baker. "It's more expensive but it's the only way to go."

Amplifier failures

In an area that experiences numerous amplifier failures, it's important to look at the fuses, says Storer's Ehman. "The manufacturers fuse lightly to protect their equipment and their good name," he says. "Every time you replace a fuse in the beginning, increase it 30 percent or so from the original equipment until you find you're burning a few modules, then back off one step. That will reduce your fuse blowing nuisance-type outages," he says.

Another way to overcome a specific problem is to talk directly with the manufacturer to work out a solution. That's what Media General's Dattner and Jones' Kernes have done.

"I probably have 30,000 to 40,000 fuses in my system," says Dattner. "So if I blow a dozen fuses per week, it's really a low percentage but it's a lot of fuses." If you feel uncomfortable experimenting with fuse values, Dattner suggests talking with the guy on the bench who built the amplifier.

It's also important to improve your system in the areas you do have control over: namely, technician training.

"They make a lot of compromises when they put that fuse in and it may not be the best one for your part of the country. So it never hurts to get to the guy who put it in there and try to get his criteria for why he did it."

Worth says it's a good idea to lab test and select the amps that have the best immunity to surges. Additionally, Worth said he'd like to see amplifier manufacturers surge test every port of each amp to a standard "appropriate for cable" and then publish that specification. "I think that would help," he says.

After doing as much as possible to overcome outages caused by circumstances beyond your control, it's also important to improve your system in the areas you do have control over. First and foremost is proper technician training and an effective preventive maintenance program, says Dattner.

"Those two things are critical in every operation and underline everything we do in terms of service, installation and everything else," he says. "If you do a good job on those two things, you get 90 percent of your problems taken care of."

Liberatore says he's in the process of improving the training program at Adelphia. "I think it goes a long way in outage control. First of all, it makes a guy a better trained technician and secondly, I think it charges his batteries a little," he says.

"I think we need to work on some of the basics," adds Liberatore. "A lot of our guys do a good job but they're not sure why they're doing it. As an engineer myself, I like to know why things happen—it makes my job easier."

All the engineers contacted agreed that eliminating outages goes a long way to improving customer satisfaction, but Telecable's Worth says even more needs to be done. "We really feel we have to do the things we're doing and more in the future because subscriber tolerance for cable interruption is going to be lower and lower."

Important lesson

One of the first places to look when you receive complaints of outages is within your own policies and procedures, advises Viacom's Baker. A few years ago, Cleveland city officials presented the system with a list of outages—many just temporary, brief interruptions—and asked the company to explain them. And although each could be identified as just normal, routine maintenance, Baker said an important lesson was learned.

"When we saw what we were doing to ourselves, we came up with some hard and fast rules that said that on any given trunk line, including the bridger, we will not turn off the system for sweeping, construction or headend work during the prime time viewing hours and that eliminated 90 percent of our reported outages," Baker says.

—Roger Brown

Fiber migration to LANs and local loop

Since the late 1970s, fiber optics increasingly has been the medium of choice for long-distance transmission of voice signals by common carriers and private switched telephone networks. In the past few years, telco metropolitan trunks—especially in congested urban areas—also have migrated to fiber. But, in the years ahead, we undoubtedly will see increasing use of fiber in the local, campus and metropolitan network markets.

Massive quantities of fiber optic cable have gone into the long-distance and trunk portions of the telephone network since 1980. The local loop and local networks are next.

That migration will occur at least partly because the big buyers of fiber —long distance communications carriers—are nearly finished constructing their networks. So the big push from fiber manufacturers will have to shift elsewhere. AT&T Communications, for example, is nearing the end of its fiber optic buying for long-haul traffic. By early 1987, the company should have 10,000 route miles installed, and that just about completes the system. Most of that cable is already ordered. MCI Communications Corp. has about 2,-500 miles of fiber installed and is looking to add 2,500 to 3,000 more miles this year. Ultimately, MCI's fiber mileage should total about 7,000 miles. Again, not too much buying remains to be done.

At the Bell operating companies, though, fiber installation continues briskly. Ameritech, one of the bigger buyers, plans to spend some $89.9 million on fiber this year. It spent about that much last year, and about $45.3 million in 1984. Southwestern Bell probably will buy $122.9 million this year, up from $76.1 million or so last year, and a whopping increase over the company's 1984 expenditures of $22.8 million.

Without question, a big driver for fiber at the local loop level is the threat of bypass. With competitors offering broadband transmission capabilities, the phone companies are reacting to protect their markets by adding even more wideband capacity than is needed at the moment. And although high-speed interoffice links have been the emphasis so far, it's safe to say the local Bells are taking a look at how lower-speed and shorter distance equipment might fit in.

Which isn't to say the state-of-the-art hasn't been changing at nearly the speed of light. Recently, 565 Mbps was the standard. Fujitsu, though, recently developed an 810 Mbps system. And engineering work continues feverishly on 1.2 and 1.7 gigabits per second speeds. But higher transmission speeds alone will not ease the spread of fiber technology to local loop and LAN markets, because the problem of optical switching and splitting still bedevils researchers.

In fact, a recent report by Frost & Sullivan, a New York research firm, predicts 76 percent per year growth for the fiber optic LAN market. The company estimates that although fiber accounts for only 5 percent of the LAN market in 1984, it will be 15 percent of the market by 1990.

But cost is still a factor at the moment. Although installation and maintenance costs aren't far out of line with coaxial cable, the transmission and distribution gear is. Optical sources, detectors, connectors and multiplexers can really push the cost of a fiber LAN up.

Ungermann-Bass, a major Santa Clara, Calif., LAN supplier, has experience in baseband, broadband and fiber nets. And most of the fiber LANs the company has installed are inter-building runs specifically designed for lightning immunity or message security. In most cases, fiber isn't cost-competitive with coaxial cable, the company believes.

That could change in the next few years, though. Optical transceivers in the $100 range should be available in the near future. That compares with a current cost in the $300 to $400 range. And optical connector and splicing technology is improving rapidly. Howard Brunke, vice president, engineering for Teleport Communications, says "AT&T has a rotary splice that's so easy to do, I could teach it to anybody in five minutes."

"The interoffice and long-haul markets are saturating, and it's in the local loop, especially distribution, that the significant sales will be made in the next few years," says Robert Bowman, president of Telco Systems Fiber Optics Corp. As early as 1988, the inter-office market could be saturated, Bowman believes. In fact, he argues that within three years the local loop will surpass the long-haul and inter-office trunk markets in size of sales.

As that change occurs, the relative proportions of fiber and transmission equipment in the total system mix will change, Bowman says. Now, 65 percent of the sales represent fiber, and 30 percent to 35 percent are transmission equipment. But fiber in the local loop will require three to five times more hardware than does the inter-office market, he adds.

Significantly, video services are seen as a possible driver for rapid local loop penetration. Brunke's company is the firm that runs the New York Teleport and already has 130 miles of fiber running in Manhatten. And while he's in a business communications, not consumer, video market, he argues that "PC terminals in the home will lead to fiber drops in the home. That'll free the voice line up. Higher-clarity video might be the driver after that."

Bowman agrees with that assessment, although he's more inclined to see local loop growth in two areas: distribution feeder and point-to-point connections for very high-density areas. Of course, as one Bell Atlantic Corp. purchasing vice president has said: "More economic fiber cable for the feeder area would make it more feasible for the operating companies to run fiber into homes and office buildings."

A Southern Bell network planner was also forthright. "We are starting to deploy a fiber network that will extend into the home. Using one terminal that can handle voice, video and data, the consumer could control energy management, receive pay-per-view TV, and query a data base for information."

Government, aerospace and local area network markets are emerging, while the long-haul market will be flattening, says Joseph Hicks, senior vice

Fiber will be used in local area networks, it seems safe to assume.

president, sales and marketing, for Siecor. Although feeder loop probably is the near-term target, "Fiber drops to the customer premises will dwarf everything we've seen to date," he argues. "By 1990 some $600 million in subscriber drop will be installed, and possibly $5 to $8 billion by 2000."

And while LANs are widely seen as a major growth area—perhaps the biggest growth area in data communications in the next few years—"fiber doesn't really solve any problems for the typical LAN user right now," says Albert Bender, president of FiberCom. "Most of the existing applications are for short distance, low-speed communications, and fiber doesn't offer an edge there. It is being used where security is very important or where the environment is electrically noisy."

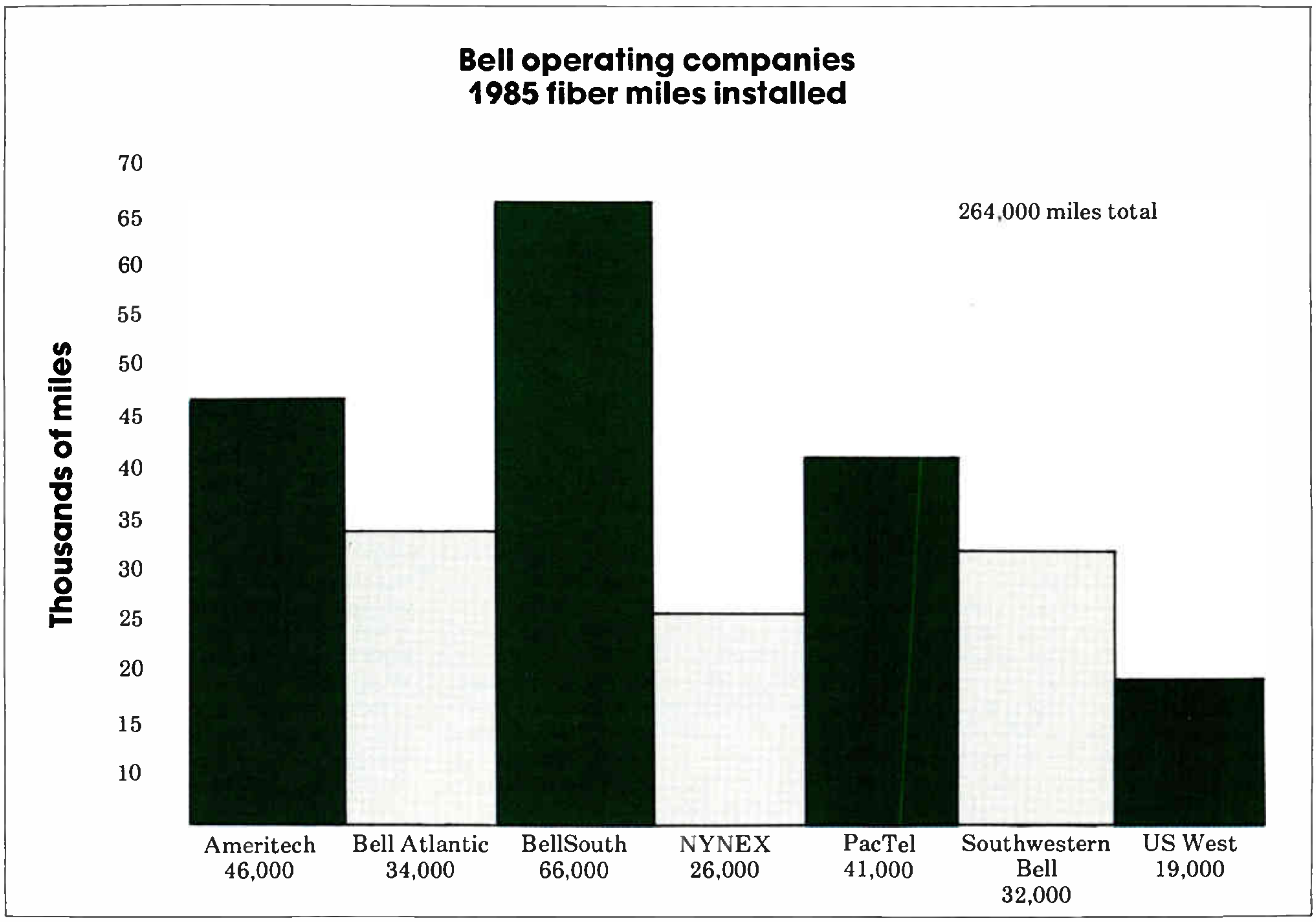
Right now, AT&T Network Systems has to be counted the leader among turnkey suppliers. But Siecor, a joint venture between Corning Glass and Siemens AG of West Germany, is pushing hard. ITT Corp's Electro-Optical Products Division, Ericsson Network Systems and Northern Telecom also are players. Major systems houses include companies like Plessey Telecommunications of the United Kingdom, Fujitsu, Rockwell International, NEC, and Telco Systems.

Siecor began looking at local loop applications about 1985, and now has about 2 million km of fiber installed in the United States, nearly equalling AT&T's base. The company decided to set up a network of sales offices selling to the Bell operating companies, and introduced a feeder cable system to link central offices. The feeder can handle 565 Mbps, although Siecor thinks most local telephone companies will run transmissions at about 45 Mpbs. The company estimates that between 1986 and 1989 there will definitely be a slowdown in fiber industry growth with the competition of the inter-city and long-haul networks, followed by a big subscriber loop push after 1990.

Fiber will be used in local area networks, it seems safe to assume. It's already being used for trunking applications at the local telephone loop level. What's harder to predict is lightweight technology's spread to the subscriber drop portion of the local telephone system.

Note: Bender also says that "only with a strong demand for subscriber services can the big move to fiber occur." And more than one observer has commented that the real driver has to be video—without video, fiber doesn't make sense.

—Gary Kim



What you need is a one-handed economist. . .

CATV suppliers who've decided to chase the growing broadband local area network market don't necessarily agree on how to identify or cultivate potential buyers of LAN equipment and services. But all agree that it is frighteningly tough to find those customers cost-effectively. Still, some vendors expect the LAN portion of their business to rival their CATV business in five years or so.

What types of companies are we talking about? Distributors like Anixter Communications or CWY. Manufacturers like Jerrold, Magnavox and C-COR. Construction firms like Nacom, AM Cable or RT/Katek. Cable manufacturers like Scientific-Atlanta or M/A-COM. Test equipment vendors like Comsonics or Wavetek. Component houses like Augat or Gilbert. And even MSOs like Viacom.

Some of the players are sticking to broadband. Others are branching out into fiber optics, small-aperture antenna or microwave installations. And if you can pull 75-ohm cable, you also can pull 50-ohm cable for Ethernet. A few players—not too many—already are bidding turnkey projects. A few more would like to work up to turnkey status. It's no easy job, though.

For most, subcontracting has proven to be the best way to participate. Generally, the trick is to establish a relationship with a firm that actually bids the turnkey. That gives you a repeat business and keeps the cost of sales down.

New business

And while most of the attention now is going to new networks being installed, down the road a new business is certain to emerge: maintenance. Broadband networks need periodic tweaking, and few owners of turnkey systems can afford to keep a staff occupied full-time doing that. So providing you can cluster your customers, maintenance contracts will emerge as a new revenue stream. And not just for suppliers. In some cases, CATV operators may have just what's needed: an experienced staff familiar with the ins and outs of broadband network maintenance; tools and equipment to do the job, and a local base of operations. Running a CATV system, in and of itself, doesn't mean a company's qualified to maintain a data network. You need a grasp of the fundamentals of data communications, experience with tight, two-way type plant and knowledge of data test sets, for example.

> . . . Because, on the one hand, LANs are a good market. On the other hand, you'll have trouble finding your buyer.

And while most companies are uncertain about just how much new business might be out there, just about everybody thinks there's too much business to ignore. A few companies already have found niches that are lucrative and relatively free of competition at the moment. How good? Good enough that they don't want their names or niches identified.

But here, in broad outlines, are some of the markets some vendors are working. Generally speaking, current buyers of large-scale LANs are large Fortune 1000 size corporations, government agencies like the Departments of State or Justice, major universities and colleges and military installations. These networks almost always are turnkey jobs awarded to a major system integrator. Unlike the CATV industry, the end user wants to buy a complete system, not parts.

So for most historic CATV suppliers, it makes no sense at all to compete against turnkey providers like Wang, IBM or DEC. But lots of companies report getting subcontracts from large turnkey outfits like TRW, Sytek, Electronic Data Systems, Allied or RFI. By and large, distributors, manufacturers and construction firms will most easily participate in the broadband LAN market as subcontractors to system integrators.

That's the easy part. But in all candor, Augat Broadband's Ed Knapp, market development manager, admits that "we've been somewhat confused about the correct way to market our products: there's no defined right way." Augat first started looking at the LAN market four years ago, seriously for the last two years. For the past three years the company has sold a LAN amplifier, and has modified its product line in other ways as well, adding custom LAN headends, for example.

Market analysis

Here's Knapp's market analysis. "Sometimes an end user will set his own specs, contract for the job and supervise its installation. Other times, parts of a job are farmed out to system architects, vendors or specialized distributors or resellers. Sometimes jobs go to specialized contractors." The problem is, all these sales occur, all the time. "The big question is how to reach them all cost effectively," Knapp muses.

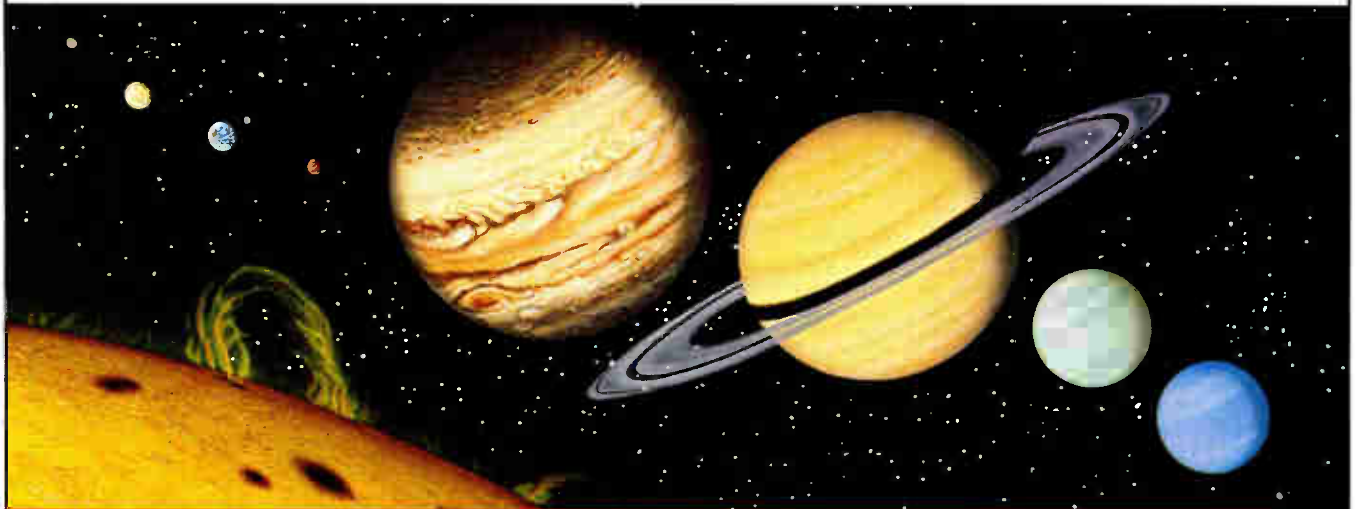
Augat is trying to adapt itself to shifting lines of distribution, though. The four major components the company sees are: computer manufacturers like IBM and DEC; multi-vendor system integrators like Allied and RFI; specialized turnkey systems like Sytek or Ungermann-Bass; and customer direct sales to companies like Dow Chemical.

Another point: some companies have relied on the same distribution channels for LANs as for CATV. Not so, Augat. From the beginning, it set up alternate channels, using direct one-on-one sales presentations, mostly. The idea was to present an entirely new image to the LAN customer. According to Bill Ellis, president, the company is working on some possible new distribution agreements that will help establish the separate LAN sales effort.

It's something to consider, because many companies active in the field have already found out that a CATV reputation can hurt, as well as help. Says Lectro's Steve Wagner, vice president, sales and marketing, "You can shoot yourself in the foot if you don't stress the commercial grade aspects of your gear. Many customers won't buy a CATV amplifier, even though it works fine, just because its a CATV amp."

Remember: "It's a typical industrial sale. You have to go to the specifying engineer. You don't go to the actual buyer first," Wagner emphasizes.

CWY Electronics, which made its first LAN sale in 1979 to Indiana University, breaks the markets out this way. "The customer we're seeking," says Terry French, vice president and



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Reader Service Number 34

Many companies would like to find a way to address a niche market that everyone else is ignoring.

general manager, "is the original equipment manufacturer. . . the Wang or IBM; the LAN contractor. . . the Allied Data Communications or TRW; the end user. . . the General Motors or Dow Chemical; the government client. . . military or civilian; and the retail computer dealer."

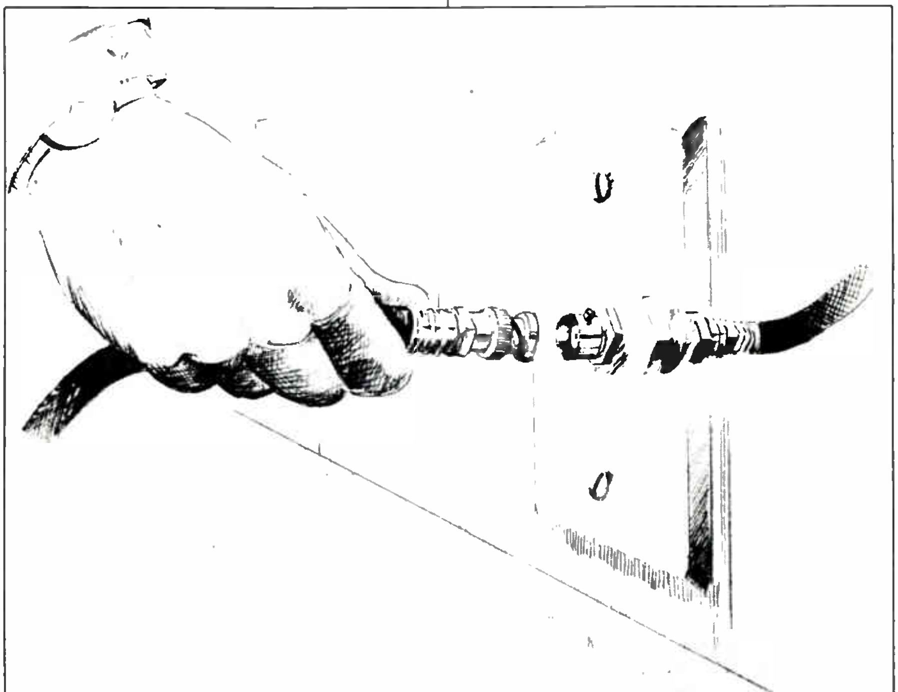
Practical targets

Of the five, though, CWY has found that only the contractor has been practical as a sales target so far. "Contractors are the only customers we get repeat business from. Also, a lot of OEMs prefer to work directly with an equipment manufacturer. Like many other companies, CWY points out that the cost of sales to a single end user can be prohibitive. On the other hand, the company would like to find a way to address one niche market that everybody else seems to be ignoring: the retail computer dealer installing small PC LANs of 40 terminals or so. Still, French emphasizes that the government is by far the major client so far. So, "our job is to get on the bid list," he adds. "Our entry level is at the time of contract letting—when the specs are written."

That's important. Ken Wood, product manager with Augat's LRC group, says the main thing is to "make sure your products get put into the bid specs." That's tough, sometimes. "There's so much legwork when you're dealing with the government," Wood wistfully says. "Even TRW does three types of jobs: work for the government; building of its own LAN system; and installation of internal TRW facility networks. It's a maze that's difficult to straighten out." Not to mention the intricacies of selling to the Bridge Communications, Nestars, Proteons and 3Coms out there.

To give you an idea of the time involved, LRC got its first order from TRW late last winter. It took 18 months of work to get it. And keep in mind the idea of niches. It works. "We do a lot of custom work and that's the only way we'll make it as a company," Wood emphasizes. Also, remember that LANs use a much smaller volume of hardware than a typical CATV job.

Another problem: the buy recommendation usually has to come from the engineering and evaluation people. The rub? "They're pretty busy and do a lot of their work off-site," Wood



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Reader Service Number 36

Everybody agrees that one of the biggest challenges is getting to know your buyer.

says. So it'll be hard to reach them. LRC is doing a lot of work with Air Force bases, and another thing to keep in mind is that you'll have to move fast once you get an order. "It's a combination of real arduous hunting for leads, followed by orders that must be filled 'urgently'," Wood adds.

There's a real risk in custom work, of course. You've got lots of design time invested, and the client could change his mind. Almost as bad, the order could be too small to fully recover your development costs. Again, the niche concept is important. "Anybody can do an assembly. Not everyone can or will test every single piece for reliability—we do," Wood points out.

Different approach

Jerrold takes a slightly different tack. Some years ago the company bought an outfit that ended up being its RF Systems division, and is now part of Jerrold's distribution systems group. The approach: working with a network of several hundred electronics contractors like Clover Electronics in Detroit. "We may design systems and do bills of materials, but the contractors actually bid the jobs and do the installation," says Ed Leahy, advertising manager with the LAN unit. For the time being, that will remain the primary emphasis, although future selling directly to end users or to OEMs isn't ruled out.

M/A-COM's network cable products group began the diversification move into LANs some three years ago, and has found its business to be the reverse of CATV. Says Dale Sherill, "75 to 80 percent of our business is with distributors; about 20 to 25 percent to OEMs like IBM, DEC and Wang; none to end users." And while projections are risky at this point, it's possible the LAN market could grow to 50 percent of the cable group's total sales within five years.

Most companies have actively sought business in LANs only recently. Alpha Technologies, for example, "found itself being drawn in without being aware of it," says Bob Bridge, sales manager. "A couple of years ago we saw them as odd CATV jobs." Not anymore.

Alpha has gotten sizeable jobs from Boeing, TRW and RFI; and a bit of work from EDS. Not surprisingly, the company plans to seek business with other system integrators. What the company's learned is that LAN customers don't care whether a power supply is uninterruptible or not, so long as there's redundancy. Still, all Alpha supplies are being designed so UPS is an option.

Magnavox first noticed the market a few years ago, but only began pursuing it in earnest about nine months ago. Like other manufacturers, the firm is discovering it must pitch its products on two levels: to the actual end user as well as the system integrator, even though the sale is direct to the contractor. Magnavox also is attending standards meetings like the MAP/TOP Users Group and trying to meet IEEE specs for broadband LAN products.

High priority

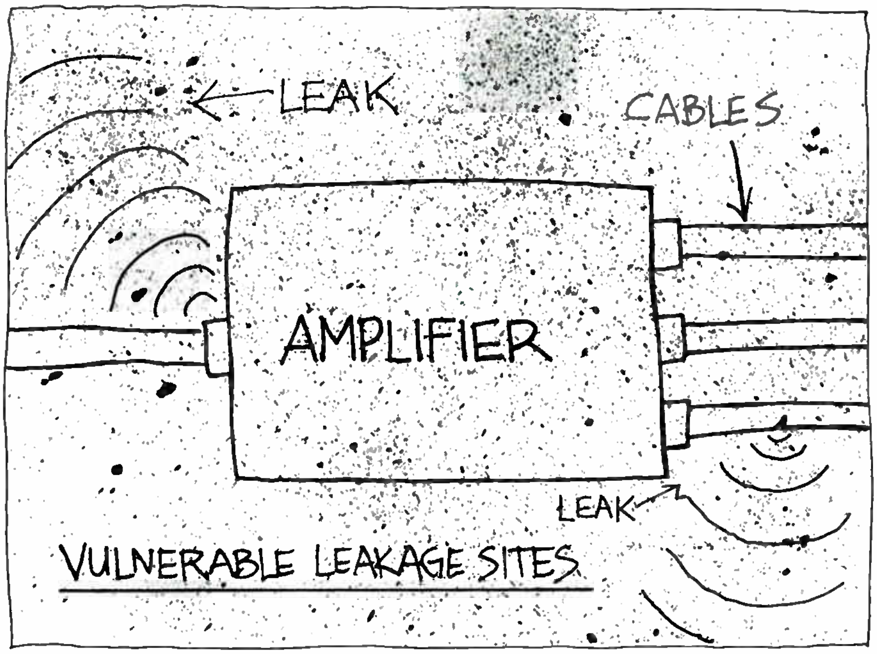
Experienced or not, everybody agrees that one of the biggest challenges is getting to know your buyer.

"Our highest priority is to identify and get a relationship with the potential users of broadband LAN installation services," says Larry Brown, vice president, LANs for Nacom. His approach? Use a strategy similar to CATV: get to know the MSOs. In the LAN world, that's tough, because the ballpark includes system integrators, manufacturers who will farm out construction work and, in some cases, even a sophisticated end user. To date, Nacom has done 10 jobs, mostly for Sytek. One of the advantages experienced installation houses may have is that the physical network itself is a relatively small part of the total cost of a LAN; in the range of 10 to 20 percent, Brown says. Most system integrators would rather concentrate on the intelligent portion of the network.

Keep in mind that bonding capability will be essential for many jobs. In other cases, there may be union labor requirements. Always, it will pay to

Wavetek Report 3: LAN Leakage

Is strange d;ata leak!ing in2to you)r LAN?



No matter how well it's maintained, every Local Area Network is susceptible to leakage. Yours included.

It's a subtle problem. Often unnoticed. Or unnoticeable. Perhaps even overlooked.

But leakage is serious, nonetheless. With equally serious consequences.

Ingress, in. Egress, out.
The causes are simple. The diagnosis, however, isn't.

Leakage occurs because of a breakdown at any of the vulnerable points. A loose cable. A corroded fitting. A nick in the cable. Usually, something minor enough that won't take the system down.

Which is precisely why leakage goes undetected.

LAN leakage comes in two forms.

Ingress, where data seeps into your system from outside. Or *egress,* where your system is, in effect, broadcasting data that may interfere with airborne or other frequencies.

Big Brother is watching.
Egress leakage has the potential to be the more severe because it often affects off-air, shared frequency services.

Your data leaking out threatens airline communications. It threatens military communications. It threatens emergency communications.

The problem is real. Leakage is a very sensitive issue. One that is attracting more than casual attention from the likes of the FCC and FAA.

Already, the FCC has formulated rules to address CATV leakage. Can LAN be far behind?

If LAN operators don't police themselves now, they'll face potentially severe government regulations and fines. Both very costly.

The threat is real, too.

Good in, garbage out.
Ingress leakage, while not as potentially dangerous as egress, can be costly in its own right.

It threatens the integrity of the system you were hired to maintain. RF energy from outside sources, such as CB radios or other high level sources, seeps into your spectrum. It doesn't belong. It's unwanted. It messes things up.

Transmission error rate increases. System reliability decreases.

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Reader Service Number 38

Some companies are developing new hardware to serve the needs of business data users.

send the best talent you've got. Too, the physical environment can be quite different: I-beams; electrical surges; pulls through chemically volatile work areas, and high RFI and EMI from large machines. Amplifiers will need to hide in closets or plenums, splices will have to be tight.

To get a grip on the business will take some work. One vendor routinely calls reporters who do stories in communications trades on companies getting LANs. Others read *Commerce Business Daily*. And a new stack of reading material is essential. Some read telephone or data processing trades. Others favor the slew of publications with the name "Communication" someplace on the masthead. Visits to LocalNet, Communications Networks and Interface trade shows also are considered "musts" by experienced players.

The LAN business also is seasonal, partly because construction schedules favor the better weather, more importantly because there's a lag between the start and end of a procurement and purchasing cycle. That can take a while. Keep in mind, too, that once all clearances are given, the customer will likely want delivery within 30 days. That can be next to impossible to comply with.

But there are lots of land mines waiting out there. For one thing, it's a business that takes more technical sophistication than some companies are used to. And even when you've got the knowledge of data communications, there are some jobs you don't want. "You can get over your head and get burned very easily," says one knowledgeable observer. "You have to know when you don't have enough information or skills to proceed with a bid." Adds another observer: "Some companies already have done themselves some harm by not knowing what they were doing." To avoid those kinds of dangers, RT/Katek's LAN/stall division, for example, has a policy of only sending the better personnel from its construction and installer groups.

In some cases, companies are developing new types of hardware to serve the needs of the business data user. Augat's LRC division, for example, has developed a self-terminating connector that is unique at the moment. Because it automatically terminates whenever the interface is disconnected, ingress and egress problems growing from unterminated ports are eliminated. The unit withstands unlimited disconnects, an important consideration when devices are frequently moved from port to port. Also, all components are held inside the main housing, improving RF integrity.

Factory networks are a special case in point. Downtime in a manufacturing

Status monitoring in CATV has come to mean modules plugged into trunk amps.

setting can run up to $6,000 a minute, so rapid fault isolation is critical. Typically, CATV status monitoring systems have been located only in trunk amplifiers. That helps, but not so much as a system that monitors all active devices on the system, from headend to drop. Also, it isn't enough to monitor one frequency alone, such as a pilot carrier. A system to monitor the entire bandwidth of the system is better. Hot standbys are one way to backup a system, especially if the cut-over is executed automatically. Not many CATV-type monitoring systems have this ability however. Component redundancy also helps. What's nice, though, is to get immediate notice when a primary unit has failed and the backup has kicked in.

Status monitoring

Traditionally, status monitoring in CATV has come to mean modules plugged in to trunk amps. Typically, a single frequency is monitored in each direction, and information is gathered on return feeder attenuation, cutoff, power supply and battery status, voltage level, temperature, load or charger status. That's good, but is limited by the total number of monitoring stations on the network. The Network Technologies division of AM Cable, though, seems to have come up with a better mousetrap, especially for downtime-sensitive factory automation applications. The company soon will be distributing its new TMC-8000 Technical Monitor and Control System, which has some interesting abilities.

It monitors multiple pilot carriers in both directions: headend to end-of-drop as well as end-of-drop returning to the headend. As many as 250 remote sensing units connected to the network are automatically interrogated, identified and tracked once attached—no operator intervention is required. Additionally, the TMC-8000 automatically reports on the location and signal frequency of any measurement outside operator-configured parameters.

Here's another nice feature. The system is user-programmable as far as level readings. You can poll any frequencies from 40 to 400 MHz in 50 kHz increments. An intelligent A-B switch is under development that will be located at the end of certain critical drops. It will switch from A to B cable or vice versa in case of complete cable failure or failure in only a single direction on either cable.

Now focusing primarily on design, construction and certification of networks, Network Technologies hopes to use the TMC-8000 to develop maintenance agreements on a wide scale. The company also would like to OEM the product and is in discussions about that now. To round out the product, the firm is completing work on interfaces that will monitor vital signs on various makes of amplifiers, focusing on three popular lines at first.

C-COR, meanwhile, remains a leader in the broadband LAN market, and first recognized the potential about five years ago. It began then to develop specific amplifiers and other products just for LANs. It also began doing system design and proofs, and like other manufacturers, finds the end user business much smaller than the system integrator market. End users are about 20 percent of the company's business, says Dick Faulkner, regional account executive. At the moment, C-COR probably holds about 50 percent of the entire market in its lines of business, built on a reputation for reliability. In fact, MTBF figures for company actives are in excess of 500,000 hours. Faulkner says some recent studies indicate something more on the order of 57 years in some cases.

In addition to its amplifiers and translators, the company also has come out with telemetry packages and an intelligent A-B switch that automatically routes signals in systems with redundant cable paths, whether single or dual-cable.

Wavetek Indiana finds that its CATV-type products need more tailored offsets and closer alignment to meet the needs of the LAN market. The company also has worked to make cosmetic adjustments so its products look like they belong in a lab-type setting. But the basic performance is much the same. Wavetek guesses that LAN business could be as big as its CATV business within the next five years.

Comsonics also has been busy selling products like the Sniffer in LAN

Continued on page 84

Optical fiber moving into new world

Fiberoptic applications are rapidly growing in number as the use of the technology moves from concentration in long-distance telecommunications into local environments.

The initial benefits of optical fiber made it irresistible as a replacement for copper media for handling the enormous distances and amounts of information traveling across the country or even around the world. And these applications will continue.

But optical fiber is becoming the media of choice for other sorts of applications, including transmission between and within buildings, from machine to machine, in networks, and even within a single piece of equipment.

These new applications are leading to a wide range of new hardware designed to meet the needs of local optical transmission. Long-distance fiberoptic transmission has moved toward a set of components optimized for that particular area—single-mode fiber, laser diode transmitters, APD receivers, and operation at 1300 nm or 1550 nm wavelength.

Just as the copper world has found that there is no universal solution (coax is not used everywhere), the optical world is moving into a set of different components optimized for the developing local environment.

Key reasons for the adoption of fiber in these environments, aside from its superb attenuation characteristics, stem from its high data rate capability, electromagnetic immunity, ground-loop elimination, security, small size and expansion capability.

The last factor is becoming increasingly important, as users are emphasizing investments in technology that will wear well in the future and not be outdated before being put into operation. Most of today's applications are limited more by the electronic capabilities at the ends of the fiber than the fiber itself.

A major advantage in using fiber technology is that future improvements will involve changing the electronics only and not the fiber itself. Today's installed fiber will undoubtedly serve applications for many years in the future.

Robert K. Southard, AMP Incorporated

New optical fiber applications are leading to a wide range of new hardware to meet the needs of local optical transmission.

This paper concerns the design of fiberoptic systems. Information on a wide variety of materials for fiberoptic installations are detailed in AMP's OPTIMATE Fiberoptic Interconnection System (Catalog 83-718). Since the catalog also contains an introduction to basic system components, this information will not be repeated here.

System specification

In some instances, fiber will be used to replace copper. The system architecture will already be defined, and the system specification will be aimed at duplicating or enhancing the existing system performance.

In other cases, totally new applications will face the challenge of taking maximum advantage of optical technology. In either case, this paper will aid in the decision-making needed to define, design, and evaluate a fiberoptic system properly.

System architecture will address such issues as making the best tradeoffs between transmission system performance and system complexity. Since digital systems ultimately deal with parallel data, decisions will need to be made regarding the degree of multiplexing to be implemented vs. the number of fiber channels to be used. In some cases, the use of slower parallel optical channels will save sufficient circuitry to justify their implementation.

Some situations may entail the need to transmit data in relatively infrequent high-data-rate bursts. Tradeoffs must be made on the use of more complex circuitry to buffer the data vs. a simpler approach that uses a higher speed optical link that will operate without buffering.

After system-architecture concepts are evaluated, a data rate for the optical channel will be established. Methods for encoding the data will need to be evaluated. Factors that enter into the selection of a code including adding redundancy to the signal to enhance error-free detection, enriching the data stream to ensure a minimum data required by the optical link, constraining the duty cycle of the signal as required by the optical receiver, and including sufficient transitions to allow clock recovery and synchronization.

The simplest of these, such as NRZ, may be ideal for the application, while more complex codes might be required for the additional features that they provide.

The choice of a particular code can be quite significant to transmission system specifications. For example, a signal with a 20-Mb/s data rate that is encoded by one of the relatively simple-to-implement bi-phase codes will require a link with twice this capacity in bits per second—the same capacity as a link carrying a 40-Mb/s signal using NRZ code. Each bit of data requires up to two signal symbols, which effectively doubles the bandwidth requirements on the transmitter, receiver, and fiber in the system.

Other codes are employed that treat a number of data bits as a set, and encode these bits with a slightly larger number of bits. These so-called group or block codes are specified as mB/nB codes, where m data bits are encoded into n bits for transmission.

Common types of group codes are the 1B/2B codes, such as the bi-phase code mentioned above, 3B/4B, 4B/5B and 8B/10B.

These codes serve many of the desirable functions mentioned above, yet increase channel capacity requirements only fractionally. This is typically done at the cost of more complex coding circuitry, however.

Additional concerns

An additional concern in establishing a system specification is the determination of the distance required of the optical channel. Both the maximum and the minimum should be established. A strategy could also be evaluated that would allow lengths longer than some maximum length, but with degraded performance. Applications may present themselves that require this longer length, but do not

The fiber of choice for local applications is unquestionably multimode fiber.

have the throughput or accuracy requirements of the bulk of the applications.

In these cases, engineering analysis may indicate that a particular optical transmission system will provide this capability with no additional redesign.

The error-rate performance of the communication system also must be factored in. A realistic estimate should be placed on the bit-error rate (BER) that can be tolerated in the transmission path, while retaining the ability of the overall system to meet its specifications.

A transmission path carrying voice or video information will most likely have a very different BER requirement than with a path carrying computer data. Stringent requirements may necessitate additional levels of data encoding, such as the use of error-correcting codes.

Higher-level system protocols may also be employed, such as cyclic redundancy checks, to monitor errors, followed by requests for retransmission when errors are detected. All these factors should be considered before establishing a BER performance requirement for the optical link under design.

The goal of system design is to use the system specification to produce a detailed layout and list of the specific components that operate together to satisfy the specifications. The many variables involved include choice of operating wavelength; type of fiber, emitter, and detector; and selection of specific transmitters, receivers, cables, connectors, and other components. Arriving at the best solution will involve a number of initial assumptions and choices, as well as analysis and evaluation of tradeoffs.

Many local fiberoptic applications will be best met by operation in the 800 nm to 900 nm optical wavelength window. Very good performance and relatively inexpensive components are available for these applications. Evaluating system performance in this wavelength range would be a reasonable approach, unless other information has already proven the need to move to other wavelengths.

The fiber of choice for local applications is unquestionably multimode fiber. This fiber allows the use of relatively simple and inexpensive LED emitters and PIN diode detectors. Multimode fiber will provide good attenuation and bandwidth performance in the 850 nm wavelength range and even better performance in the 1300 nm range.

Next, the system specifications are used to determine which transmitters and receivers are appropriate, based on signal characteristics such as data rate, duty cycle, and so forth. In some cases, a transmitter or receiver will be close to meeting the defined needs, but may have excess capability in some areas, and insufficient capability in others.

For example, an application might require 100-Mb/s transmission with a given power budget and with a BER of 10^{-9}. A receiver specified at 100-Mb/s and a BER of 10^{-12} may operate properly due to the tradeoff between data rate and bit-error rate. Information on these tradeoffs, as discussed later, and engineering analysis will be needed to resolve these issues.

After these initial decisions have been made, system design turns to the analysis of establishing signal integrity through the fiber system. Evaluation of link performance is carried out in two main areas—optical power and bandwidth.

The design will need to proceed along both lines, with the interactions between the two areas continuously examined.

Power budget

The key elements in a simple power analysis of a fiberoptic link (transmitter, fiber, and receiver) are:

- transmitter power out, into a specific fiber, P_T
- fiber attenuation per unit length, A_L
- receiver sensitivity or minimum input power, P_R
- connector and component loss in the fiber path, A_C
- link margin, M

The typical process of working through a power budget involves making initial selections of potential components for the link and then proceeding with the power calculations. Expressing the loss and link margin values in dB and power values in dBm, the basic formula is:

$$M = P_T - A_L \bullet L - A_C - P_R$$

where L is the length of fiber in the system. Multiple fiber segments are simply combined algebraically.

FIGURE 1

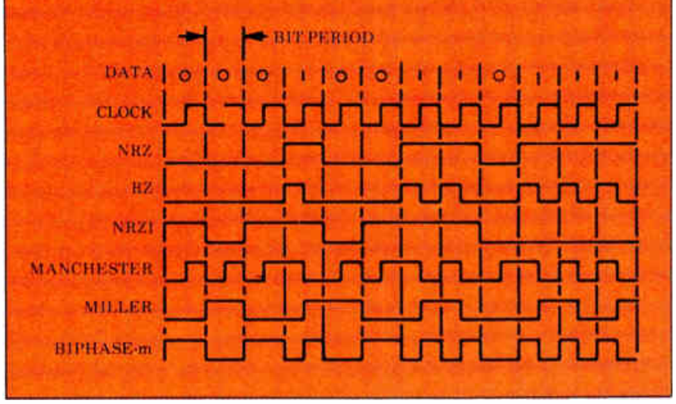

FIGURE 2

Format	Symbols Per Bit	Self-Clocking	Duty Factor Range
NRZ	1	No	0-100
RZ	2	No	0-50
NRZI	1	No	0-100
Manchester (Biphase-1)	2		50
Miller	1	Yes	33-67
Biphase-m (Bifrequency)	2	Yes	50

Values for connector loss, fiber attenuation and length can be used to determine the margin of the system.

The transmitter power and receiver sensitivity are taken from the appropriate data sheet, typically in units of dBm. Normally, peak power values are used throughout the calculation.

This is based on a 50 percent duty-cycle signal, so that average power is one-half of peak power. That is, average power is 3 dB below peak power.

Any inconsistency here will cause sizeable errors to occur. All AMP specifications are in peak power.

Values for connector loss, fiber attenuation, and length can be used along with the information on the transmitter and receiver to determine the margin of the system. Acceptable limits for margin are highly dependent upon the application. Links that are put into service with no changes expected in the future may require relatively little margin.

On the other hand, links that are expected to be extended in distance or to receive additional connectors and components will need appreciably more margin in anticipation of this additional attenuation.

Consider an example typical of local area networks. An 85 μm core fiber is initially selected for analysis. A 100-Mb/s transmitter/receiver pair is selected based on data rate. Data-sheet information indicates a launched power of —16 dBm for the selected fiber, while receiver sensitivity is given as —30 dBm worst-case. Connector loss is expected to be 1.5 dB maximum per matched pair with up to two connector pairs anticipated in the link. An estimate of the required margin is made—for example, 5 dB for component aging and possible link repairs and extensions.

Rearranging the above formula and calculating the total allowable fiber loss gives:

$$A_L \bullet L = -16\ \text{dBm} - 2 \bullet 1.5\ \text{dB} - (-30\ \text{dBm}) - 5\ \text{dB},\ = 6\ \text{dB}$$

Selecting a fiberoptic cable that has an attenuation of 5 dB/km will then allow a link length of 1.2 km, based on power budgeting.

Fine-tuning

The previous analysis is a much simplified approach, although very useful. More precise calculations involve the realities of dealing with an optical fiber as an electromagnetic waveguide whose properties are extremely complex.

In addition, most component specifications are themselves simplifications. Although it is not possible to treat these subjects fully here, some additional discussion will aid system design.

The importance of transient vs. steady-state loss is apparent in short fiber-length systems.

Multimode fibers and cables are normally specified to have a certain attenuation, given in dB/km, under certain optical launching conditions. A typical test for this parameter is the cut-back method. This involves the launching of power into a 1 km to 3 km length of fiber and then measuring the optical power at the end of this length.

Most of the fiber is then cut off of the test set, and the optical power is measured on the remaining short stub. The attenuation value so derived is accurate for the particular length and for the optical launching conditions used in the test, but may not accurately reflect the loss under other conditions.

When power is launched into a multimode fiber from a source that fully covers the area and numerical aperture of the fiber core, a relatively large amount of power is contained in high-order modes in the fiber, and may result in a loss of from 1 dB to 1.5 dB when they are removed from the fiber.

This causes the total power in the fiber to drop quickly at first, and then more slowly as the higher-order modes are dissipated.

The loss due to the higher-order modes is called the transient loss of the fiber, while the loss due to the lower-order modes is called the steady-state loss.

The importance of transient vs. steady-state loss becomes apparent in systems having short fiber lengths. For sources that fully excite the fiber modes, larger attenuation will be experienced for short lengths than would be predicted by the linear attenuation assumption of using a constant dB/km.

Conversely, other sources, such as LEDs with microlenses, do not fully fill the fiber, and thus do not produce as large a transient loss as in the fully-filled case.

Connectors can also affect transient loss behavior of the fiber. Losses due to connectors near the launching end of the link will tend to selectively attenuate the higher-order modes, which would have been attenuated in the fiber anyhow.

Overly pessimistic loss accounting can occur if this phenomenon is not considered. Conversely, connectors placed where a steady-state mode distribution exists may cause some power to be coupled into higher-order modes,

Data	4B/5B Code
0000	11110
0001	01001
0010	10100
0011	10101
0100	01010
0101	01011
0110	01110
0111	01111
1000	10010
1001	10011
1010	10110
1011	10111
1100	11010
1101	11011
1110	11100
1111	11101

Example Group Code

thus causing additional transient loss in the fiber. The data sheet values given for AMP components tend to include some of these additional losses that would typically be experienced in short-distance applications.

Although connector and fiber measurement techniques are being developed to characterize this behavior better, current engineering must be undertaken with the knowledge that the data sheet specifications are approximations of actual system performance.

The minimum receiver sensitivity of −30 dBm in the previous example is based on several variables or test conditions that affect actual sensitivity. The key factors to be considered are actual data rate, required BER, and duty cycle.

The maximum data rate specification of the receiver is based on a number of variables, including the bandwidth of the preamplifier circuitry in the front-end of the device. At the maximum data rate, the high-frequency roll-off of the amplifier will be attenuating the signal to some degree. At lower signal rates, the amplifier will provide somewhat more gain, so that less signal is required to achieve the same output level from the amplifier.

This information can be used to advantage in applications having a data rate below the maximum specified for the receiver. At a particular level of BER, additional sensitivity will result.

In these cases, the receiver may be used with an appropriate reduction in the sensitivity level.

Receiver sensitivity is characterized at a particular BER based on standardized or widely accepted values. However, certain applications may involve either higher or lower BER.

Duty-cycle variations in the signal presented to the receiver will affect different types of receivers in very different ways. While a later section will discuss this in more detail, the degradation of BER as the duty cycle varies from 50 percent, for a receiver with a restricted duty cycle operating near its maximum data rate. The change in BER can be referred to an equivalent power.

A DC-coupled receiver, will handle any duty cycle without degrading the BER. Applications having very specific or unusual duty-cycle requirements can be addressed through making tradeoffs as indicated in these curves.

Bandwidth budget

The previous section indicated that receiver performance depends on data rate as well as signal level. Additional consideration of the data rate capability of a link is obtained from the bandwidth budget. The receiver is usually the most bandwidth-limiting component in a fiberoptic link.

In many instances, the transmitter, interconnection hardware, and fiber will not have a major degrading effect on overall system performance. The bandwidth budget is an important technique to determine the effects of the transmitter and other system components on link data rate.

Although the term bandwidth generally applies to the frequency-domain characteristics of a system, the information-carrying capability of a link can be equally determined in the time domain. Pulse broadening is one time-domain—or digital—approach commonly used in fiber measurements, while rise-time and fall-time values are more commonly used in electrical engineering.

Analysis here will be oriented toward the latter; the term transition

Connectors and splices do not contribute to limiting the bandwidth of the system.

time will be used to refer collectively to rise time and fall times. In this sense, transition time should not be confused with propagation time, or transit time, which refers to the time it takes signals to pass through a device or fiber.

If the maximum NRZ data rate of the receiver is denoted B, then the bit time, T associated with this data rate is simply:

$$T = 1/B$$

The following empirical rule will be established to check system bandwidth; the effective transition time of the optical signal entering the receiver, t_S, should be less than 70 percent of the signal bit time, that is,

$$t_S = 0.7T = 0.7/B$$

As long as t_S is shorter than this value, the full system bandwidth will be primarily limited by the receiver capability.

If t_S is longer than this value, link performance will begin to be limited by some element other than the receiver. When the signal into the receiver has a long transition time, the result will be an increase in BER level, or a decrease in sensitivity of the receiver for a given BER value.

The major items that combine to degrade (lengthen) the transition time of the signal into the receiver are:

- transition time of the transmitter, including the emitter, t_E
- transition time due to fiber modal dispersion, t_M
- transition time due to fiber chromatic dispersion, t_C

Connectors and splices do not contribute to limiting the bandwidth of the system. Studies have indicated that they can, in fact, improve performance somewhat by causing mode mixing, which can reduce modal dispersion.

The most commonly used method to combine the above terms to determine a value of t_S is a square root of the sum of the squares formula:

$$t_S = (t_E^2 + t_M^2 = t_C^2)^{1/2}$$

The transition time of the transmitter, t_E, is included in the transmitter specifications. Where rise time and fall time are individually specified and unequal, the slower should be used for worst-case analysis, but a more reasonable value of this purpose would be the average.

The transition time due to modal dispersion in the fiber is given by:

$$t_M = D_{MOD} \bullet L^Q$$

where L is the length of the fiber in km, and q is a constant that indicates how the modal dispersion scales with length. Some published estimates for q indicate that a reasonable value about

Chromatic dispersion is due to the material and waveguide properties of the fiber.

0.7, but this value applies primarily to very long fiber systems.

Other estimates for q place its value for short system at approximately 1. D_{MOD} is a value that indicates the amount of modal dispersion due a particular fiber. Since the above function is nonlinear with length, it is important that a value for D_{MOD}, in units of ns/km, be obtained with a fiber length of 1 km, or at least at some known length.

If a value of D_{MOD} is not available, the best estimate for modal dispersion is based on the bandwidth specification for the fiber, B_F. Estimates for the resulting transition time are obtained from

$$t_M = 0.44\, L^q / B_F$$

Since transition time, and thus bandwidth, may not scale linearly with length, it is clear that specifying bandwidth, B_F, is specified in units of MHz.km is not a precise indication of actual performance.

It is accepted commercial practice to publish fiber bandwidth in MHz.km, however, without indicating the test conditions or length employed for the specification. These bandwidth values can be used with the knowledge that they are only valid if obtained on a 1 km length.

If it is known that the bandwidth was obtained with some other fiber length, L_O, then transition time due to modal dispersion is given by:

$$t_M = 0.44/B_F \cdot (L/L_O)^q$$

Thus, as an example, given a fiber bandwidth of 200 MHz.km (obtained at 1 km), a fiber length of 300 m, and using q = 1, we have

$$t_m = (0.44)(.3\text{ km})/(200\text{ MHz.km}) = 0.66\text{ ns}$$

Chromatic dispersion is due to the material and waveguide properties of the fiber. For multimode fiber in the 800 nm to 900 nm wavelength range, wave-guide dispersion can be neglected. In this wavelength range, common glass fibers have a material dispersion, D_{MAT}.

Values for D_{MAT} in the literature are sometimes shown as positive and sometimes negative. A positive value is required for the calculations that follow.

$$t_C = D_{MAT} \cdot \Delta\lambda \cdot L$$

where $\Delta\lambda$ is the spectral width of the source. For an LED transmitter with a 50 nm spectral width and 300 m of fiber having a material dispersion of 0.1 ns/nm/km, the calculation is

If improved optical signal transition time is desired, a faster transmitter is one item to consider.

$$t_C = (0.1\ \text{ns/nm/km})(50\ \text{nm})(.3\ \text{km}) = 1.5\ \text{ns}$$

Due to the relatively large spectral width of LEDs compared to laser diodes, material dispersion in LED systems operating in the range of 850 nm will often be more limiting than modal dispersion.

At 1300 nm, the situation is more complex, since material dispersion is very low. In this case, wavelength dispersion should be considered, and an accurate value of modal dispersion will be quite important.

With the above information, the optical transition time into the receiver, t_S, can now be estimated. Assuming that the transmitter transition time, t_E, is about 4 ns, and using the above examples,

$$t_S = (4^2 + .67^2 + 1.5^2)^{1/2} = 4.3\ \text{ns}$$

For a 50-Mb/s receiver, the permitted transition time into the receiver is given by:

$$0.7/B + 14\ \text{ns}$$

Thus, the calculation indicates that receiver performance would not be degraded at 50 Mb/s for the values chosen. The above equations can be used to determine the maximum fiber length that could be used in this example before t_S would exceed the specified limit, and thus degrade system performance. This calculation indicates a maximum length of about 2.5 km.

If t_S exceeds the limit indicated above, the optical transition time will cause receiver performance to be somewhat less than optimum. This may be acceptable, particularly if the link is being operated at a data rate lower than the maximum rate specified for the receiver.

In this case, the reduced receiver performance due to slow optical transition times will be offset by the increased sensitivity due to the lower data rate. In general, receiver performance may be quite acceptable in such a case, due to other margins in the design.

If improvement in the optical signal transition time is desired, a faster transmitter would be one item to consider.

A final word of warning is in order. The calculations made above involve a large number of approximations and empirical estimations. In situations that are borderline in nature, more exacting measurements will have to be made. Performance measurements on actual components, including both power and BER studies, will be needed to confirm actual system capability. ■

product profile

Standby power supplies

Company/ Model	Output power	Output current/ voltage	Regulation	Battery voltage
Alpha Technology UP-960	900 W	15 amps/ 60 VAC	± 3%	36 VDC
C-COR NB113C	900 W	15 amps/ 60 VAC	± 2% line/load normal mode	36 V
Cable Power CL737-15	900 W	15 amps/ 60 VAC	± 2% normal mode (AC), standby mode (DC)	36 VDC
Control Technology Citation II	720 W	12 amps/ 60 VAC	± 3% (58-62 VAC)	24 V, 2 batteries
Data Transmission Devices SP 720	720 W	12 amps/ 60 VAC	± 3%	24 V
Larson Electronics LE 60-9PS	15 amps/ 60 V	15 amps/ 60 V	± 5%	36 VDC
Lectro Products Sentry II	900 VA	15 amps/ 60 V	± 3%	36 V
Magnavox AP 660-14MA	840 VA	14 amps/ 60 VAC	± 3%	36 VDC
Powerguard SB-6012-24-0	720 VA	12 amps/ 60 V	± 5% standby, 0.05% nonstandby	24 VDC
RMS PS-SB30/60	12 amps	30 or 60 V	± 2% @ 95-130 V	12 V per battery

Charge current	Recharge time	Transfer time	Standby time	Dimensions
0-9 amps	12-16 hours	<4 msec.	Function of load current & battery amp hour rating	24″W x 14″D x 22″H
5.5 amps	18 hours	<16 msec.	3.75 hrs.	23″W x 14½″D x 24″H
0-9 amps	Typ. 10-20 hours	8-16 msec.	15 hrs.-1.5 hrs. (depending on output load)	16″W x 14″D x 23″H or 23″W x 14″D x 25″H
5 amps	From low voltage cutoff to recharge: 12-15 hrs. with CD110 batteries	From line to standby & standby to line: 15 msec.	1.7 hrs. @ full load	16″W x 15″D x 18½″H
8 amps max.	12-24 hours	10 msec.	2 hrs. on full load	17½″W x 16¼″L x 24″D
12 amps max.	18 hours from battery turn-off	0.5 msec.	5 hrs. @ 840 watts	23″W x 14½″D x 19½″H
3 amps max.	12 hrs.	20 msec.	3 hrs.	14½″W x 21½″D x 20″H
10 amps max.	12-18 hours	<16 msec.	2 hrs. (depends on battery capacity & load)	24″W x 14″D x 22″H
3 amps	18 hrs. typical from low voltage cutoff	15 msec. typical	3 hours @ 10 amps	16″W x 8″D x 37″H
Cycle change	Dependent upon battery condition	16 msec.	2 batteries- 8 amps nom.: 3½ hrs.	21¼″W x 14¾″D x 23¼″H

Continued on next page

Standby power supplies

Company/ Contact	Options	Weight
Alpha Tech. (206) 647-2360	Dual-system enclosures, status monitoring on one-way or two-way plant, automatic performance monitoring. Complete array of optional accessories and configurations available.	97 lbs. w/o battery
C-COR (714) 993-2620	Status monitoring, slide-mounted battery tray, pedestal mount, additional surge protection, U.L. approved.	93 lbs. w/o battery 273 lbs. w/battery
Cable Power (206) 882-2304	Pedestal enclosure, aux. power input, automatic performance monitor, remote performance monitor, elapsed time meter, battery harness, temperature compensated battery charging circuit.	90 lbs. 95 lbs.
Control Technology (800) 527-1263 (214) 272-5544	Pedestal mount	75 lbs. w/o battery 195 lbs. w/battery
Data Transmission Devices (617) 532-1884	U.L. listed; 12, 15, 18 and 24 amp supplies; voltmeter; ammeter; self-switching generator input; lightning/ transient protection; voltage regulation; remote status monitor.	89 lbs. w/o battery

Continued on page 79

Standby power supplies

Continued from page 76

Company/ Contact	Options	Weight
Larson Electronics (817) 387-0002	Status monitoring, available w/o ferro resonant transformer, heated battery cabinet.	100 lbs. w/battery 70 lbs. w/o battery
Lectro Products (800) 551-3790	Input and output surge arresters, incident counters, status monitoring.	90 lbs.
Magnavox (800) 448-5171	Interfaces with DSS status monitoring system, ground mount cabinet. Standard features: heavy-duty surge arrester, battery cables.	N/A
Powerguard (404) 354-8129	15 amp model, 30/60 volt output, 200 joule MOV input surge protection, PIP-60 transorb output surge protection, pedestal model, elapsed time meter, cycle counter, 18 amp model.	80 lbs. w/o battery
RMS (800) 223-8312	Standby counter, standby elapsed time meter assembly; 30, 60 & 115 volt transorbs, lightning arrester, aux. battery pack, pedestal base mount, pole mounting bracket assembly, CA-3 and CA-4 enclosure locks, CA-1890 housing lock tool.	160 lbs. w/o battery

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Advertisers' Index

Give away the razor, sell the blades

It isn't often that software engineers can ignore the processing limitations of the machines they've got to use. QuickData, a new on-line computer system from CableData, is the exception. Aimed at CATV systems up to 25,000 subscribers, the system will be going to 10 Beta sites this fall, with widespread sales expected by the end of the year. About 200 systems already have signed up for the package, which handles order entry, billing, dispatch, work orders, routing control, installer performance reports and cash accounting functions quickly—very quickly. It ought to. A powerful, 32-bit NCR processor sits at the heart of the custom mini that drives the system. And note: each terminal has its own CPU and one megabyte of RAM. CableData is giving away an awfully powerful razor to sell you some blades, (916) 636-4500.

In case you hadn't noticed, Scientific-Atlanta increased its prices 10 to 15 percent on July 1.

Tektronix, meanwhile, has introduced two low-cost oscilloscopes, both featuring four-channel, 100 MHz bandwidth, and priced between $1,800 and $2,500, (800) 426-2200. Also new in the test area is the L series TDR by Lanca Instruments, (512) 388-1195.

And since July 15, remote location interfaces have been available for Jerrold addressable systems using the AH-4 controllers. The Telephone Network Adapter also can be used as a one-way data link for systems using the AH-1, AH-2 and AH-2E controllers, (215) 674-4800.

Several new headend products are out, also. Applied Instruments has a quad AB switch (standard rack mount), available in RF or video versions, (317) 782-4331. Nexus Engineering Corp. has a small, low-cost commercial block converter receiver, designed for 900-1750 MHz IF signals, called the SR-5, (206) 644-2371. Drake's Model ESR2240 commercial receiver is aimed at 950 to 1450 MHz applications and costs $899. It's available now, (513) 866-2421. Videoplex has two videoplexers specifically aimed at the CATV industry. One model displays four channels at once; the other 12 channels at once, (201) 469-9038.

In the power supply area, Power Guard is now delivering 30 and 60 volt AC non-standby power supplies for test bench operations. The five-amp version sells for $300; the 10-amp version for $330, (404) 354-8129. Alpha Technologies, meanwhile, continues to test its status monitoring system for one-way CATV plant, (206) 647-2360.

Also new: a residential security system from Imperial Products Center, (718) 784-7227 and a truck lid system from Tailgater, (408) 424-7710.

In the converter area, Pioneer has Hamlin-compatible versions of its BA-5000 addressable converter ready for shipping, (614) 876-2125.

Training opportunities

Magnavox will be running Mobile Training Center sessions in Worcester, Mass., on Sept. 17-19 and Sept. 22-24; Richmond, Va., on Oct. 15-17 and Oct. 20-22; and in Orlando, Fla., on Nov. 12-14 and Nov. 17-19, (800) 448-5171.

C-COR will be running seminars for technicians in Hartford, Conn., on Aug. 19-21; in Atlanta on Oct. 21-23 and in Dallas on Nov. 4-6, (800) 233-2267, ext. 208.

James Williamson

Moving along

James Williamson is now vice president, operations for Pioneer Communications; Jerry Nelson is sales and marketing director for CATV. Pete Wronski is rejoining the Jerrold western region sales force, while Mohsen Manoochehri assumes responsibility for Oregon, Washington, California and Nevada.

At M/A-COM, Stan Lindsay is now vice president, sales and marketing for Comm/Scope. Rusty Galbreath is leaving the company, however, and will be looking for marketing positions.

At Warner Cable Communications, Bruce Byorkman has been named technical operations manager for the Medford, Mass., complex.

Cable Link has named William Holehouse director of sales, while CWY Electronics has added Michael Phebus as a regional sales manager for Wisconsin, Iowa, northern Illinois and Indiana.

Amerilink Corp. has a new southeastern area manager: Gordon Moss.

Sonia Khademi is now eastern regional sales manager, and Ralph Patterson is western regional sales manager for Data Transmission Devices.

SCTE awards

Sally Kinsman, president, Kinsman Design Associates, got the Society of Cable Television Engineers award for member of the year at the recent SCTE convention in Phoenix. The President's award went to Showtime/The Movie Channel, recognizing the contributions of Mike Aloisi, Lynn Watson and Joe Girard in chapter development. Showtime/TMC also donated six months of satellite time to the SCTE in 1985.

Two SCTE meeting groups have attained full chapter status. They are the Florida and New England chapters, bringing the total of chapters to 22.

Also, seven individuals received personal awards for contributions to the industry and achievement: Ralph Haimowitz, corporate engineer, American Cablesystems; Jonathan Ridley, applications engineer, Jerrold; Margaret Abel, system designer, Group W Cable; Thomas Gorman, chief technician, Comcast Cablevision; John Green, chief technician, United Artists Cablesystems; Michael Smith, regional engineer, Warner Cable Communications; and Robert Baker, chief technician, McCaw Cablevision.

The SCTE also announced that its 1987 expo will be held April 2-5 in Orlando, Fla.

—Gary Kim

Developing products specially for MAP was a risky move, yet full of potential.

Continued from page 65

areas for about five years already, and will in the next fiscal year be making a major commitment to the LAN market, broadband for sure and possibly other areas as well, according to Dick Shimp, vice president, field services.

The Lectro division of Burnup & Sims will stick to broadband, and recently assigned Marty de Alminana to full time LAN sales. The new strategy is about four months old, and, in addition to reorganizing its sales effort, the company is releasing a series of modified power supply products to meet the special needs of the LAN user. A new Mini Brute supply that is wall-mounted, not strand-mounted, is such a product. The unit also has an integral fan—a big selling point to users whose gear is in poorly-ventilated closets. Redundancy also is a special LAN feature. The unit also comes in a rack-mounted version. A rack-mounted standby unit designed for LAN use features a six millisecond switch time.

Bob Dickinson, now doing business as Dovetail Systems, says he's got a product under development in the leakage area, and is starting to do some network integration as well.

Perhaps the most ambitious, and most risky, proposition tackled to date by any traditional CATV vendor was undertaken by Scientific-Atlanta. You've been reading a lot about the growth of interest in the Manufacturing Automation Protocol. S-A's approach to the market has been to push its expertise at the physical layer of broadband networks, whether MAP-compliant or not. But the company went beyond standard broadband products and designed a MAP-compatible modem. The prototype already has demonstrated its interoperability in the MAP environment, something no other vendor in CATV can match. S-A also developed a MAP-compliant remodulator, both products addressing the standard's 2.1 version. Because the stream of purchase orders for MAP products has been extremely slow recently, both products are in a bit of limbo now.

Gutsy move

Developing products specially for MAP was a gutsy move, and while it involved more risk and potential than many other strategies, the move points out a fact of life for anybody trying to make money in LANs: although everybody's coming to the party, it isn't clear where the party's being held.

What is important for any manufacturer, though, is to get the specs for the equipment written into the document when the request for quotes goes out. "Most end users are buying turnkeys, not electronics," says S-A's Pat Miller, marketing manager. "What's important is that they understand the difference between our product and others. So we find we've got to stimulate the market a little bit."

Miller also makes a good point about the factory automation market as a whole: MAP isn't the whole market. "Many stand-alone controllers will still be used, because not everyone can afford full computer-integrated manufacturing."

And like most other players in broadband LANs, S-A has found that users generally put in LANs to handle data. Gradually they find other uses.

Zenith Electronics also adapted existing CATV expertise for the LAN business, releasing its new Z-LAN 500 system, a 10 Mbps LAN supporting 10,000 nodes and using five six-MHz channels sub-divided into 500 kbps allocations. Z-LAN uses the CSMA/CD signaling technique, and remote diagnostics and network management are built right in. A strong point: much lower C/N ratios than comparable products on the market.

Even MSOs are looking at the business. Viacom Telecommunications already has a dedicated private network unit. At other companies the emphasis seems more localized. Heritage's Jim Randolph, director of engineering, has quite a big data transport operation running, mostly at T-1 rates. Most of the customers in Dallas seem to be using the conduit for bypass of the local telephone company. And while most of the activity is on existing CATV plant, he "gets calls every day from big corporations who want LANs." ATC thinks there's a business out there somewhere in data transport, but hasn't yet finalized any specific plans.

Not everybody is jumping in with both feet, though. RMS Electronics knows there's a market out there, but has no particular plans to alter the way it now does business to chase it. Likewise, Reliable Electric isn't looking aggressively right now because there isn't an immediate fit with the existing manufacturing base. Kennedy Construction also has done a few jobs, but isn't quite sure how hard to push, although the company certainly wants to diversify.

CATV Subscriber Services, for its part, first began discussing the LAN market about three to four months ago, and thinks its installation, construction and design activities in CATV and private cable ought to help. Basically, the company sees itself providing subcontracted installation services for turnkey operators.

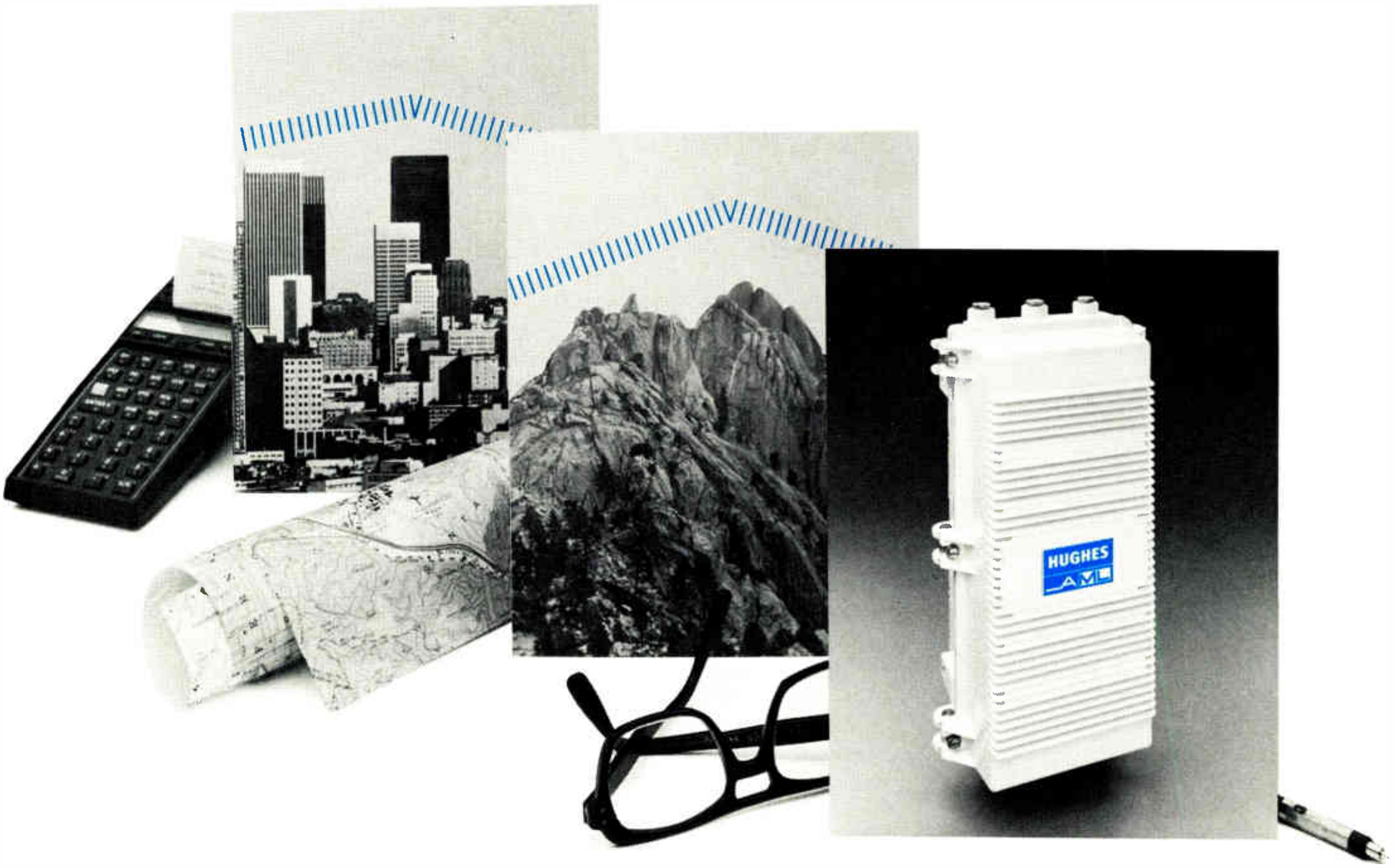
And some companies want to stay away from certain aspects of the business entirely: NCS Industries, for example. It got its first LAN job about a year and a half ago, doing system proofing and supplying equipment. It will stay away from construction work, however. Modem repair is okay. "We'll stay away from cable, strand and other stuff that takes up warehouse space," says Dick Grasso, president. "We work the high tech end of the business." The basic strategy? "We don't stand up to the big IBMs and TRWs. We pick up what they don't want."

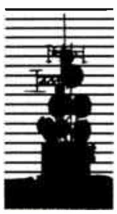
Not surprisingly, perhaps, supply giant Anixter, with its heavy base in the telephone world, has made one of the biggest internal reorganizations to tap the LAN market. Essentially, the company has merged its CATV/broadband product lines with Ethernet, IBM Cabling System and data communications product areas, offering a more unified, multi-media LAN effort. Accompanying the internal moves is a new emphasis on smaller, and more numerous stocking locations.

As far as pursuing the LAN market, Anixter can deliver—from one integrated unit—broadband, baseband, or IBM Cabling System options. The company also is making a big effort to supply physical layer products to MAP vendors and users, without much question the biggest such effort in the industry.

—Gary Kim

FINALLY, A PRACTICAL SOLUTION TO OUT-OF-SIGHT MICROWAVE TRANSMISSIONS.





Until now, all microwave systems shared this common problem: transmissions that weren't line-of-sight often drove costs out-of-sight. But with the new low-cost Active Repeater from Hughes Aircraft Company, you can now get around those obstacles and profit from areas previously too expensive to serve.

The easy to install Hughes 2-watt MWB-122 Active Repeater is directly compatible with all CARS band transmitters and receivers including Hughes AML® systems. It is outdoor mounted, totally self-contained, and its low power requirements are easily met by a small DC or solar power source. Whether your microwave path is blocked by man-made or natural obstacles—and whether your transmission is AM or FM—the MWB-122 stands alone as your most practical solution.

This Active Repeater is the latest development in the most comprehensive line of CARS band microwave equipment available. The Hughes AML Microwave Line includes an entire selection of low, medium, and high power transmitters and receivers suitable to every application. In addition, Hughes offers the product quality, experience, and support services that really can remove all obstacles from earning greater profits.

Find out more about the Hughes MWB-122 Active Repeater. Contact: Hughes Microwave Communications Products, Bldg. 245, P.O. Box 2940, Torrance, CA 90509-2940 or call toll free (800) 227-7359, Ext. 6233. In California (213) 517-6233. In Canada: COMLINK Systems Inc., 1420 Bayly Street, Unit 5, Pickering, Ontario L1W 3R4, (416) 831-8282.

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4711 Golf Road
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(312) 677-2600

JOHN M. EGAN
President

August, 1986

An Open Letter to the CABLE-TV Industry:

Manufacturers have been hard hit by the evolution of the Cable-TV Industry from heavy construction to an operating and maintenance market.

With this new environment, the industry must address the growing disparity between the success of operators and the current plight of these manufacturers. From their point of view, the maturing of their industry has been painful and the future looks bleak. From the operator's point of view, the future has never been brighter.

Anixter has served the Cable-TV industry from its beginning, by providing innovative solutions to the industry's product and supply problems.

Anixter Communications sees its role as supply and service specialists working with both manufacturers and operators to eliminate duplication of effort and to reduce manufacturer's and operator's inventory and operating expenses. Anixter also sees its role in helping manufacturers to improve their production planning and provide fast service to operators from strategically located warehouses throughout North America.

While many suppliers are giving up and leaving the Cable-TV industry, Anixter continues working with those who remain, helping them bring their products to the marketplace.

Cable-TV has been a key factor in making Anixter a substantial New York Stock Exchange Company. We are extremely strong financially, and we are recommitting ourselves to the continued growth and prosperity of this industry.

IN THE NEXT FEW MONTHS YOU WILL SEE US BACK OUR WORDS WITH ACTIONS. IN THE MEANTIME, IF YOU HAVE ANY IDEAS THAT WILL HELP OUR INDUSTRY, PLEASE CALL US SO WE CAN WORK ON IT TOGETHER.

John M. Egan
President

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CORPORATE HEADQUARTERS: ANIXTER BROS., INC.
4711 Golf Road, Skokie, IL 60076 (312) 677-2600 — Telex 289464